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ham radio

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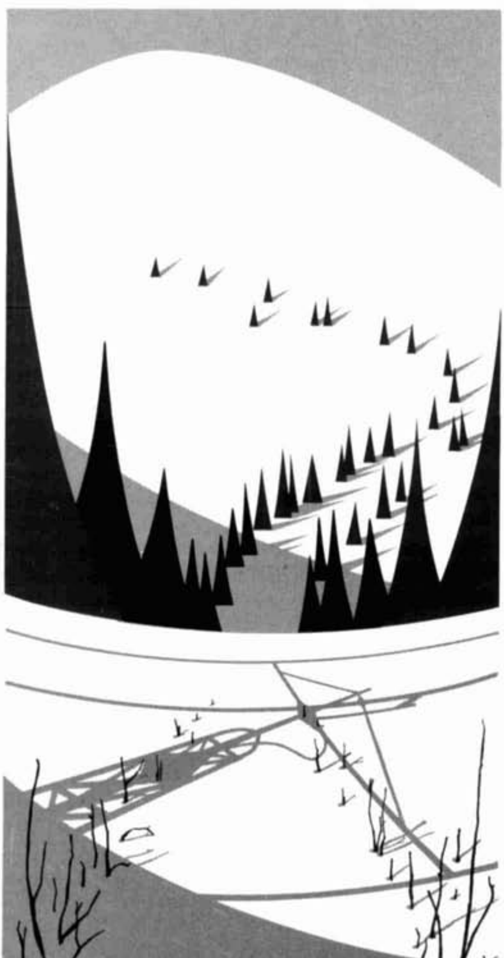
DECEMBER 1971



this month

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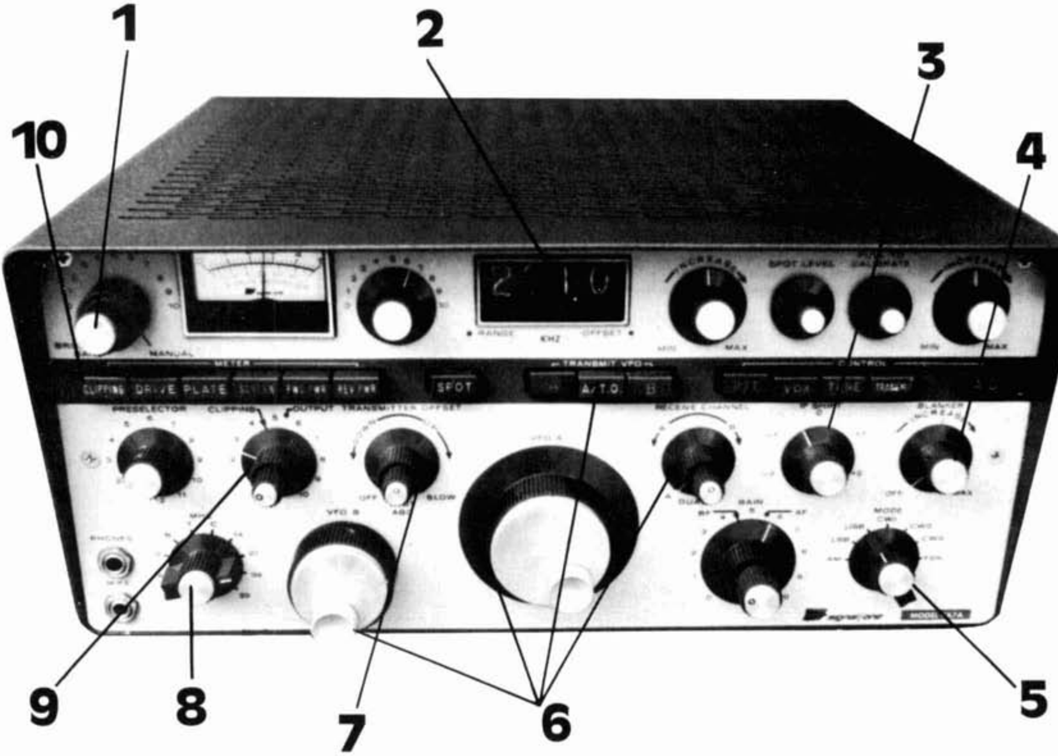

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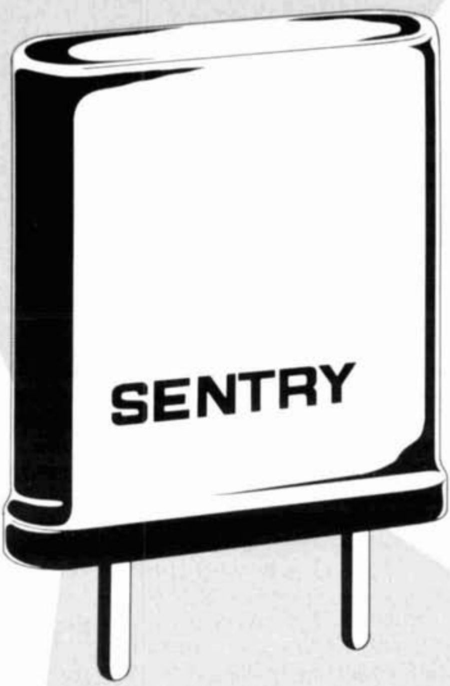

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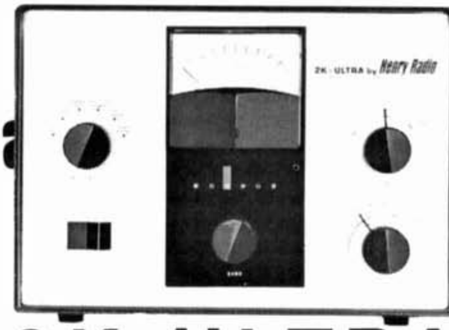

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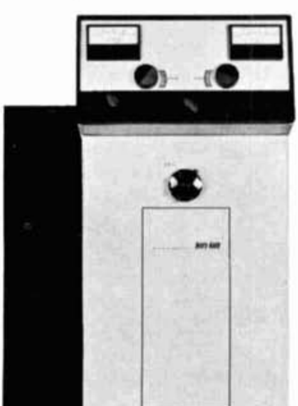

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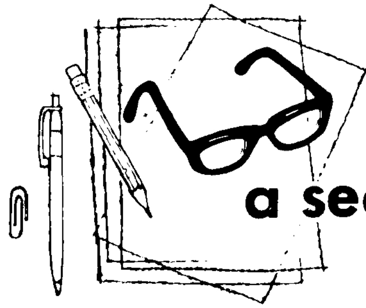

a second look

by jim fisk

Radio engineers from the U. S. Department of Commerce are creating immense, invisible heated bubbles in the upper atmosphere with a new 100-million-watt radio beam. The short-lived bubbles are formed in seconds at altitudes up to 200 miles and grow to their full 50 to 100-mile size in about 20 minutes. Composed of the electrified gas of the ionosphere, the bubbles elongate upward and downward under the force of the earth's magnetic field.

Observations of these effects on the upper atmosphere should lead to a better understanding of the ionosphere and improvements in long-distance radio communications. Within minutes or hours, depending on the time of day and conditions in the high-level environment, the modified region of the ionosphere rebounds to its natural state.

The new high-power transmitter, located in Colorado, uses a nine-element circular array of antennas, 360 feet in diameter, with an additional element in the center for beam focussing. The system is capable of projecting effectively a 100-megawatt radio beam that is tunable between 5 and 10 MHz, the usual range of ionospheric penetration frequencies.

The intense radio beam is transmitted straight up at very close to the penetration frequency – the frequency at which a radio wave passes completely through the ionosphere. This imparts a maximum amount of energy to the ionosphere. The closer the transmitted beam approaches the penetration frequency, the higher it reaches before being bent back to the earth, the more it is slowed down, the longer it remains in the ionosphere, and the more its energy is absorbed by the ionospheric electrons.

The electron heating takes place in about 20 seconds, more or less. The heat bubble expands more slowly, however, because the negatively-charged electrons must drag the heavier, slower-moving positive ions with them in order to maintain the electrical neutrality of the ionospheric plasma. Within 20 minutes or so the dimensions of the heat bubble may grow to 50 or 100 miles.

Measurements indicate that the radio beam raises the temperatures of the ionospheric electrons by as much as 35 percent. Scientists expected that this temperature change would cause enhanced reflections of radio signals. Unfortunately, this is not the case; radio waves reflected from the regions of heated electrons are severely attenuated.

Another major surprise is the artificial creation of a natural phenomenon known as Spread-F. Spread-F is the upper layer of the radio-reflecting region of the ionosphere which is characterized by a patchy pattern of reflected signals.

Scientists have long been looking for a technique for modifying the ionosphere as a method for studying it. They have used chemical releases, atomic bombs and small electron-beam accelerators, but none of these methods are as controllable or repeatable as the new 100-megawatt transmitter. Hopefully this new tool will lead to a better understanding of the ionosphere, and eventually, control of its radio reflecting properties. Can you imagine around-the-clock contacts on 10, 15 and 20 meters even in years of minimum sunspots? QRM could become more of a limiting factor than it is now!

Jim Fisk, W1DTY
editor

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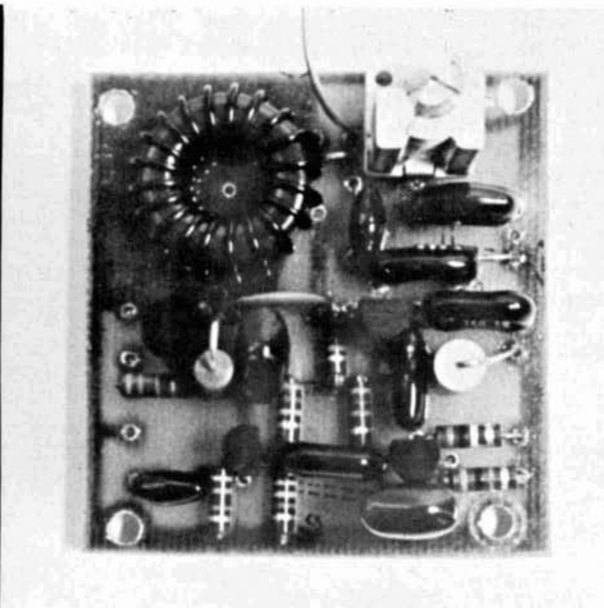


miniature solid-state variable-frequency oscillator

This miniature circuit-board can be used for either the Seiler or Vackar oscillator circuits, including the buffer-amplifier and emitter-follower

Donald R. Nesbitt, K4BGF

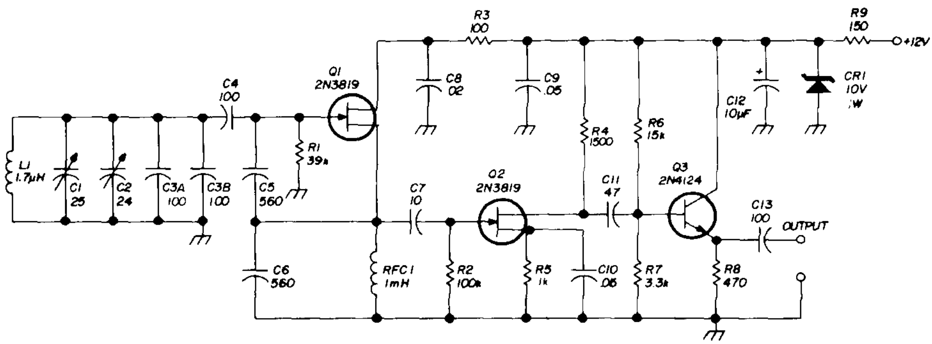
My search for a simple high-quality vfo which was small enough to justify the use of minature solid-state devices led to the design of a dual-function printed-circuit board which accommodates either the Seiler or Vackar oscillator circuits. These circuits were given comprehensive treatment by W1DTY[1] and can provide the amateur with exceptional results.

seiler and vackar circuits

Fig. 1 shows the Seiler oscillator circuit. Q1 is the oscillator, followed by an amplifier (Q2) and an emitter-follower (Q3). **Fig. 2** shows the schematic diagram of the Vackar. Again, Q1 is the oscillator, followed by an amplifier (Q2) and an emitter-follower (Q3) which are identical to those used in the Seiler circuit.

Careful study of the basic Seiler and Vackar oscillator circuitry reveals that the circuit differences involve a basic rearrangement of L1, C6, C7 and RFC1, and, in the case of the Vackar, the elimination of C8 and R3.

The padding capacitor, C3, is designated as C3A and C3B. This allows you to use two different temperature compensating values should this be necessary.



C1	25-pF variable (Millen MK21025)	C3	200 pF silver mica (total of C3A and C3B)
C2	2.4-24.5 pF (Johnson 189-509-5)	L1	1.7 µH. 18 turns no. 20 enameled evenly spaced on Amidon T-68-2 toroid core

fig. 1. Circuit of the Seiler oscillator. Components values shown tune from 7.0 to 7.3 MHz.

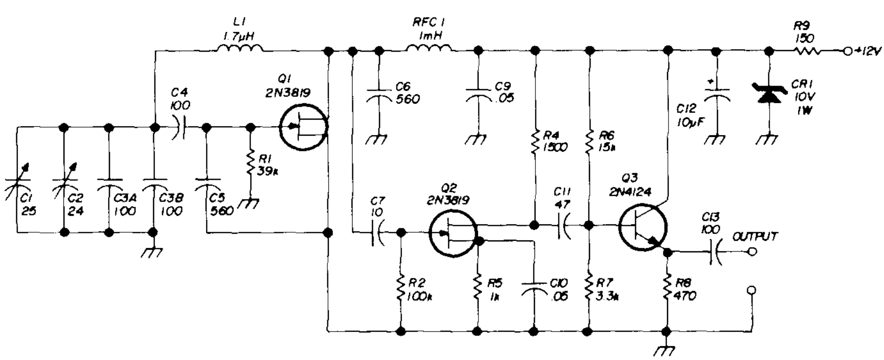


fig. 2. Vackar oscillator circuit. Buffer-amplifier (Q2) and emitter-follower (Q3) stages are the same as the Seiler circuit in fig. 1.

circuit board

Fig. 3 shows the parts placement as viewed from the foil side of the printed-circuit board for *both* the Seiler and the Vackar circuits.* Connections shown by dashed lines are for the Vackar; its associated components are designated by the letter V (ie: V-L1, V-Jumper, V-C6, V-C7, and V-RFC1).

Parts placement for the Seiler circuit can be seen by simply ignoring the

*An etched and drilled glass board (including the nine quarter-watt resistors used in the test oscillator) is available for $1.50 postpaid ($1.00 for the board only) from Technical Assistance Unlimited, Inc., 717 N. W. 1st St., Gainesville, Florida 32601.

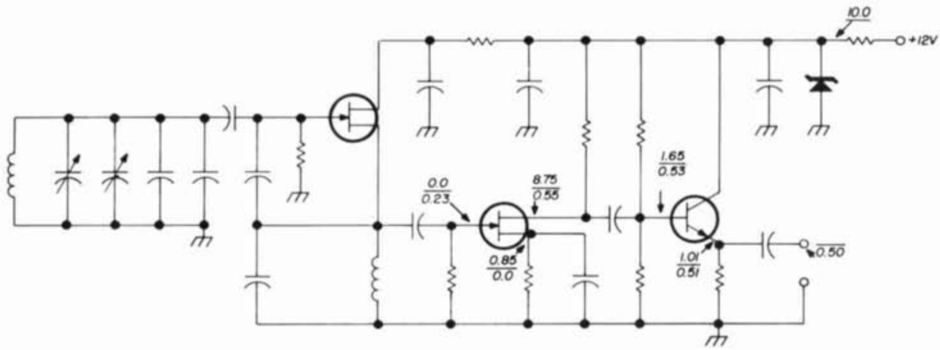


fig. 4. Dc and rf voltage measurements made on the 7-MHz Seiler test oscillator. The dc voltage measurement is the upper number; the rf voltage (rms) is below the line.

dashed lines and the V-designated connections. When the circuit board is used for the Seiler circuit *no* connections are made to holes indicated by the letters E or F.

If you begin with the Seiler oscillator,

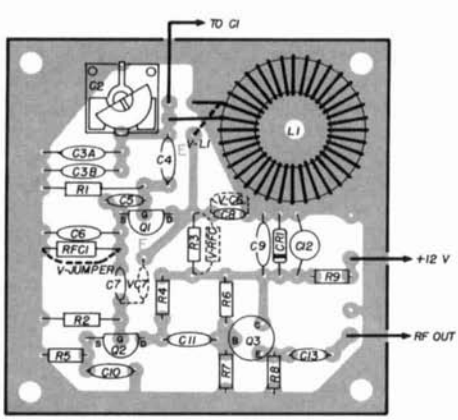


fig. 3. Parts placement as viewed from the foil side of the printed-circuit board. Seiler layout can be seen by ignoring the dashed lines and components designated by "V".

the following changes are necessary to convert to the Vackar circuit:

1. The side of L1 which was connected to ground is connected to point E.

2. RFC1 is replaced by a jumper.

3. R3 is replaced by RFC1.

4. C8 is replaced by C6.

5. The end of C7 which was connected to the source of Q1 is connected to point F.

After these five steps are completed, C8 and R3 are leftover as they are not required in the Vackar configuration.

dc and rf voltages

Fig. 4 indicates the dc and rf voltage (rms) measurements made on a 7-MHz Seiler test oscillator. Circuit values are shown in **fig. 1.** These measurements were made with an 11-megohm vtvm equipped with an rf probe. The upper number indicates the dc voltage with Q1 removed from the circuit. The bottom number is the rf voltage (rms) obtained with the oscillator functioning.

construction and test

Since this circuit board packs a lot of components in a small space it is recommended that you mount the resistors first. The quarter-watt size is preferred but half-watters may be used by standing them on end. Next, mount the capacitors, coil, choke, and zener – checking and re-checking for proper position.

The transistors are mounted last. You should mount Q2 and Q3 and check the dc voltages as shown in **fig. 4.** Any abnormal reading will allow you to find the mislocated component or faulty transistor. Install Q1, apply power and you should be in business.

The rf voltage measurements shown in **fig. 4** for the 7-MHz test oscillator can be used as a rough guide. Using the Vackar circuit, or other frequencies or components will result in rf voltages that depart widely from those of the test oscillator. Once you have obtained proper operation, you may wish to note these voltages for reference.

Failure to oscillate may be traced to a mislocated part, a bad fet or improper values at C4, C5, C6 or L1 and its associated parallel capacitors. In many cases you may have to experiment with these components to determine the proper value. In addition to the comprehensive article by W1DTY already mentioned, the additional references[2, 3] provide examples of various frequency ranges and circuit layouts.

Generally speaking, mechanical construction of the finished product will spell the difference between a "warbler" and crystal-controlled stability. The general rule of thumb is to build it like the venerable battleship; the article by W8YFB[4] is recommended reading.

"You should take up ham radio too, Marge! It's a great way to while away the idle hours."

By all means try your hand at substitutions. Some substitutions may produce superior performance. MPF102 fets may be used in place of the 2N3819s but be sure to check the base lead configuration as the gate lead is on the outside instead of in the middle. Some bending may be necessary to get the right lead into the right position, and care should be taken to insure that none of the leads are short-circuited. This substitution was made in the test oscillator, and it functioned with little perceptable difference from the original except for slightly higher rf voltages.

Toroidal inductors need not be used at L1 although they do offer a size advantage. Miniductor type stock was tried and performed very well. Alternately, the hole used to mount the toroid can be enlarged and a slug tuned coil fastened in this position. While this works, it may be necessary to adjust some of the components to get the circuit oscillating as the Q of this type inductor may be considerably lower than either the toroid or the airwound coil.

Various rf chokes with values as low as a few microhenrys were tried at RFC1 with success.

summary

This versatile printed-circuit board permits easy construction of either the Seiler or Vackar oscillator. In addition to being useful to the homebrewer in search of a small high-quality vfo, this board should keep the Seiler vs Vackar experimenter busy for some time.

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ham radio

diversity receiving system

The application of photocell modules and ICs to improve reception in the hf bands

John J. Schultz, W2EEY, 1829 Cornelia Street, Brooklyn, New York 11227

In the same sense that most family garages these days contain two or more cars, most amateur stations have at least two receivers. The second receiver may be a separate self-contained unit, or of the two receivers, one may be in the form of a transceiver. The availability of two receivers covering the same band or bands allows one to enjoy the advantages of diversity reception.[1]

The most useful application of diversity reception in amateur work is probably for ssb DX, since deep signal fading often causes missing words or entire phrases. Although diversity reception will also improve CW intelligibility under marginal signal conditions, the improvement is not quite as obvious as that with ssb since CW speed versus fade time, plus the fact that CW contacts often follow a standard format, allow one automatically to fill in missed portions. Much the same is true of RTTY, where one can see the printout of several words and fill in a garbled word.

Although commercial and government stations may use racks of equipment to obtain diversity reception with low error rates on hf circuits, the basic advantages of diversity reception can be obtained for amateur purposes with relatively simple equipment.

diversity reception

Besides having two receivers available, the other basic requirement for diversity reception is that each receiver be fed an input signal that doesn't fade in the same manner, so that the diversity circuits can choose automatically the best receiver channel at any instant. There are numerous ways to provide the differing input signals for each receiver. The commercial/military approach is usually to use space diversity. In this method, each receiver is fed by a similar antenna separated 5 to 10 wavelengths. The space between the antennas provides different signal levels as ionospheric refraction conditions vary.

Another approach is frequency diversity in which only one antenna is used, but each receiver is tuned to a different frequency which carries the same intelligence. This method is satisfactory for shortwave broadcast reception, since most major shortwave broadcasters transmit similar programs simultaneously on at least two bands to a given area. Amateurs, however, may transmit simultaneously on different bands only under restricted conditions generally defined by the FCC as serving the overall amateur interest (code practice) or during emergencies.

polarization diversity

Probably the most satisfactory diversity receiving method for hams is polarization diversity, which doesn't require the real estate necessary for space diversity. Its principle is based on the fact that a signal refracted by the ionosphere experiences a change in polarity. The change is most pronounced during disturbances in the ionosphere that produce rapid fading. Most refracted signals exhibit circular polarization, and the best hf DX receiving antenna would probably be one that responds to this type of wave. However, such antennas are generally not practical on hf.

Polarization diversity reception isn't difficult to implement in most cases, since all that's required is an antenna of opposite polarization to complement the existing antenna. For instance, if the existing antenna is horizontally polarized, a second, vertically polarized antenna is needed. The gain of the complementary antenna is not as important as the fact that it responds to oppositely polarized signals.

A rarely used method of diversity reception involves (a) cross-response, and (b) extremely different angle-of-arrival-response antennas. In the former case, similarly polarized antennas are used but have a 90° difference in major-lobe response to account for the fact that signals may be received better over different propagation paths. In the latter case, an antenna ½ wavelength high may be used to complement an antenna 1-2 wavelengths high to take advantage of the fact that, during disturbed propagation conditions, transmission over a long path may vary between 1- and 2-hop F-layer propagation with a corresponding difference in the signal angle of arrival.

Whatever antenna method is used depends upon the construction possibilities at a station. The following parts of the article describe circuits that may be used to obtain an automatic selection of the receiver for best reception assuming a given receiving antenna arrangement.

selection via avc combining

The simplest method to obtain a selective choice of receiver outputs is to tie together the avc bus of two similar receivers, as shown in **fig. 1**. The receiver with the stronger signal biases the receiver with the weaker signal to reduce its audio output. The receiver with the weaker signal is never completely cut off, however, and produces some noise output. Each receiver is shown with a separate speaker, but often the audio output of each receiver is paralleled and fed through the audio section of just one receiver, or through an auxiliary audio amplifier. Simultaneous tuning of both receivers may be accomplished by using a common local oscillator and beat-frequency oscillator. In this case, the receivers should be adjusted on a steady signal so that both produce the same output level independently. Such an adjustment is usually required only once on each band. This can be done by controlling the gain of any stage not subject to avc, or by controlling the gain of a preamp ahead of one receiver not connected to the avc line. Once adjusted the system will work quite well and will, very roughly, tend to

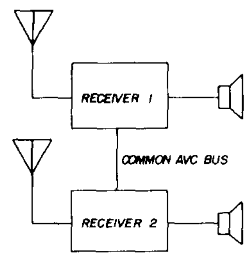


fig. 1. Simplest diversity receiving method. The receiver with the stronger signal biases the receiver with the weaker signal to reduce its audio output. Signal-to-noise ratio suffers, however, because the receiver with the weaker signal is never completely cut off.

halve the difference in input signal level to each receiver. For example, if the input signal to one receiver differs 20 dB with respect to that of the other receiver, the combined audio level will exhibit about a 10-dB change.

inexpensive and performs the audio combining or selection process almost as well as several tube or transistor stages. It's particularly effective when used in receivers with their avc buses tied together. However, it can be used with two re-

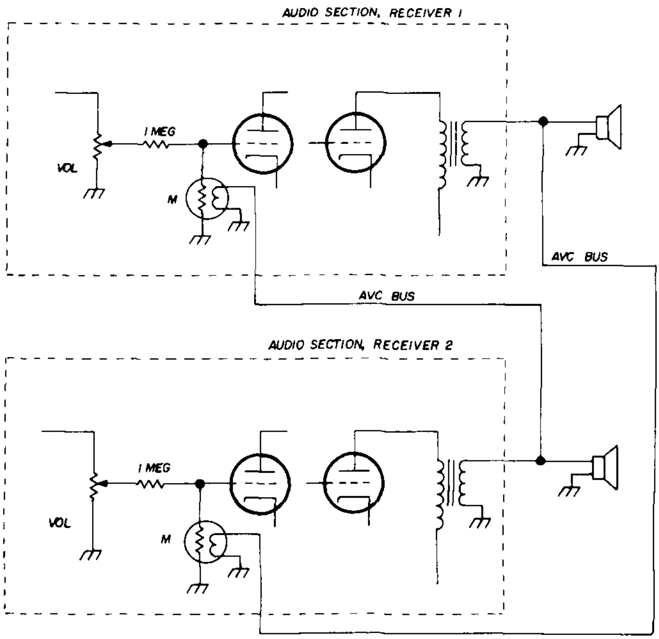


fig. 2. Addition of photocell module, M, improves diversity action of two receivers with avc buses connected, or it can be used alone with two receivers having dissimilar avc circuits. Photocell (Clairex CLM 4006) is available from Allied Radio, order no. 60F6468, at $3.25.

photocell combiner

To further enhance the differential avc voltage when one receiver input signal increases as the other decreases, a photocell operating on the audio output of each receiver can be used to advantage (**fig. 2**). The receiver with the stronger audio output energizes the photocell module in the first stage of the other receiver. The resistive element of the photocell module decreases in resistance with increasing drive, and in conjunction with the 1-meg series resistor, forms a voltage-divider that reduces the signal to the audio section of the receiver with the weaker signal.

The photocell addition is relatively ceivers having different avc circuits, which precludes connecting their avc buses together. After experimenting with the rf and af gain controls on each receiver, the photocell-only method of audio control performs about as well as the avc-combining method.

switching combiner

The main disadvantage of the simple methods described above is that the receiver with the weaker signal is never completely disabled. The combined avc/photocell method is about as far as one can go with simple circuitry; but even here, unless the difference in signal levels to the receivers is very great, the receiver with the weaker signal will provide some output and degrade the overall signal-to-noise ratio. The only way to avoid this is to completely disable the output of the receiver with the weaker signal. The rate at which the level of each receiver in a diversity system should be sampled, as well as how fast and by what means the output of each receiver can be chosen without creating switching noise, has been the subject of numerous studies and commercial design approaches.

IC diversity combiner

The simple circuits using ICs shown in **fig. 3** and **4** provide effective, low-cost diversity receiving action approaching that obtainable with expensive commercial equipment. Although diversity action would be enhanced if the unit shown were used with receivers whose avc buses could be tied together, it can be used with receivers having dissimilar avc circuits.

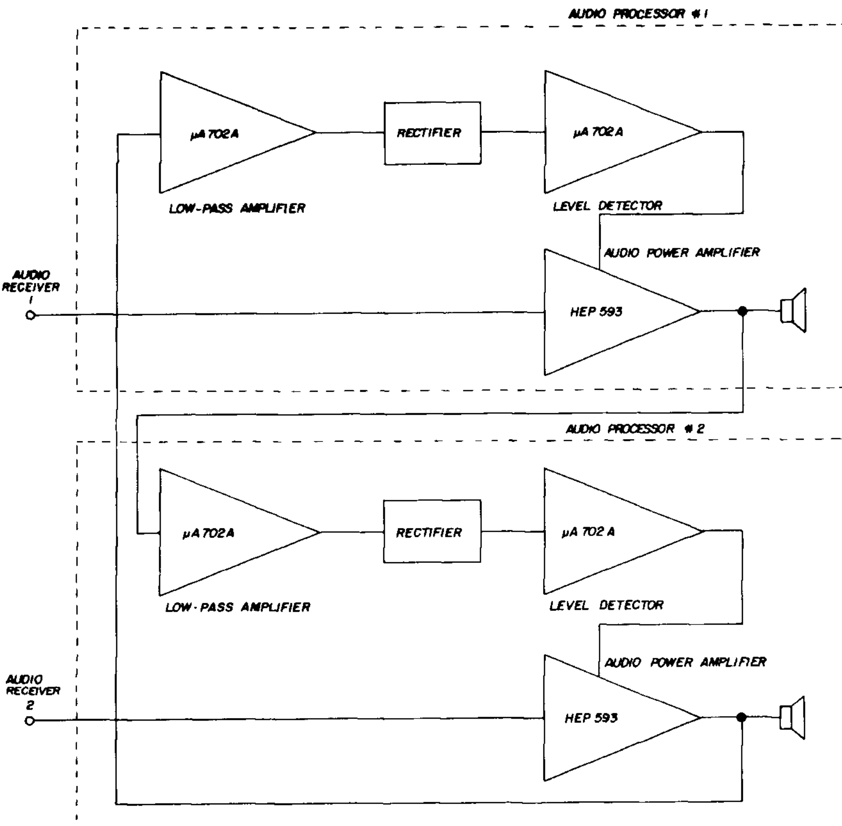


fig. 3. Block diagram of IC diversity combiner. Note that the two audio-processing circuits are identical.

As shown in **fig. 3**, the IC combiner consists of two identical audio processors, each connected to the audio output of one receiver, then interconnected. Each processor consists of a 1-watt audio power amplifier whose output is regulated by a control section consisting of two μA702A stages. The first μA702A stage is driven by the audio-output level of the power amplifier in the companion audio processor. It acts as a low-pass (2,000 Hz) amplifier. Its output is then rectified and fed into another μA702A stage, which acts as a level detector.

When the rectified input level to this stage exceeds a certain value, an output is created that is used to sharply reduce the gain of the audio power amplifier. Thus, only one audio channel will be amplified as long as it produces a sufficiently strong signal to retain control of the system at However, such a refinement would add little to the value of the unit for amateur DX receiving purposes, where the main objective is to select the receiver which, at any time, provides at least a minimum readable signal.

circuit description

The details of the circuit are shown in **fig. 4** for one audio processor. The first

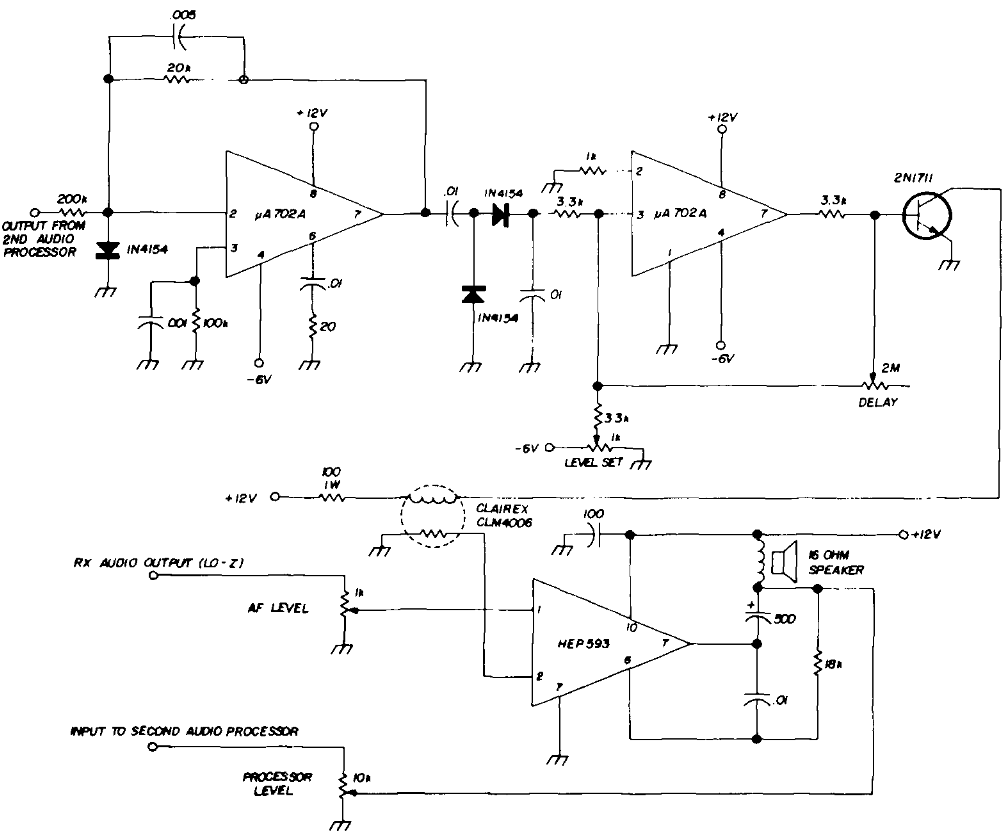
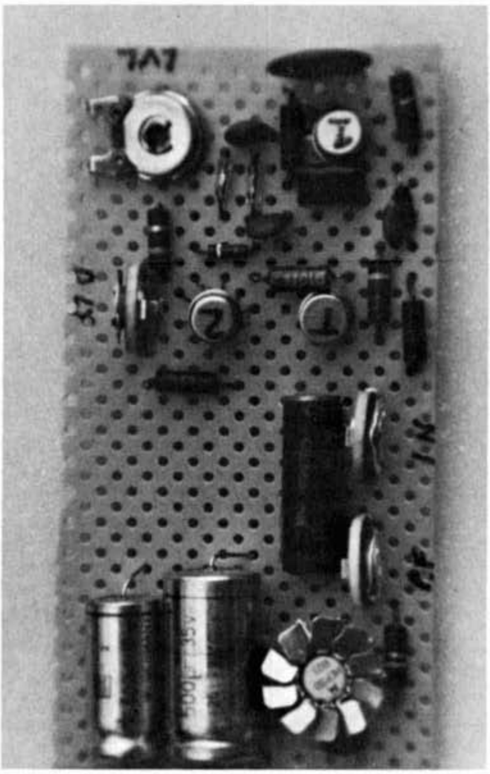


fig. 4. Complete schematic of one audio processor. Two Fairchild μA702As and one Motorola HEP593 are used.

the minimum level at which it has been set. If the signal falls below this minimum level, no output will control the system until a signal exceeds the minimum level. Only manual control of the system level is used. It is possible to provide automatic sampling of receiver levels to allow the stronger signal to set the system level. μA702A stage frequency roll-off was designed to hinder response to noise signals. The μA702A level-detector stage provides a positive output whenever the input level on terminal 3 exceeds that set by the *level-set* potentiometer. The positive output operates the 2N1711 driver transistor, which in turn switches the lamp on and off in the Clairex 4006 photocell module. The resistive element of the photocell module controls the HEP593 amplifier gain. The audio amplifier is not completely cut off by the photocell, but its gain is reduced by about 40-50 dB. This, plus the thermal action of the photocell lamp, provides a smooth switching action instead of a thump each



Typical parts layout for an experimental audio processor. The HEP593 is shown at top (with cooling fins). The two μA702A's are below. PC-board pots are used for control functions shown in fig. 4.

time one or the other audio channel is activated. A delay loop is also included in the second μA702A stage and is controlled by a 2-megohm pot. This loop, plus the rectifier circuit between the μA702A stages, prevents loss of control of the audio-amplifier stage during short-term periods of low input to the first μA702A; e.g., during brief speech pauses.

construction

The construction of the processor units is identical. Perforated-board stock may be used as shown in the photo. The pots are PC-board types, but they should be installed as panel controls. The two processor units can be packaged into a complete assembly to suit individual requirements. Separate speakers were used for each audio channel instead of using isolating stages to drive a combining audio amplifier. The cost of the components, compared to that of an additional simple speaker, didn't justify the added complexity.

The power for the two units is −6 volts at 50 mA and +12 volts at 400 mA, which can be supplied by a well-filtered transistor power supply.

adjustment

When using the audio combiner, each receiver should first be adjusted to provide the same output level for a steady input signal. This can be done with the receiver controls and the *af-level* control on each processor unit. The *processor-level* control should be set to the ground end. The *processor-level* and *level-set* controls on each processor should then be advanced equally so that one receiver just controls the system within the smallest difference in control settings between processor units. That is, a small adjustment of the *level-set* pot on either processor should cause one of the audio channels to be activitated. The *delay* control should be set under actual receiving conditions so that excessive switching back and forth between audio channels, when no marked difference in output level between channels is noted, does not occur.

reference

1. Keith Henney, "Radio Engineering Handbook," McGraw-Hill, New York, 1959, pp. 19-118; 24-19; 24-25 to 24-31.

ham radio

push-to-talk for a styleline telephone

This simple solid-state circuit provides complete push-to-talk operation with the built-in recall switch included on Trimline and Styleline telephones

John C. Tirrell, W1DRP, 164 Cypress Lane, Nashua, New Hampshire 03060

Since many of the two-meter fm repeaters within range of my base station are either controlled by Touch-Tone, or about to be, I felt that I had to become better equipped. All I really wanted was a Touch-Tone pad, but I found that just the pad (keys and tone generator) were hard to get, although obtaining a complete Touch-Tone telephone was relatively easy.

Why not get the entire phone? Perhaps I could extract the needed Touch-Tone pad. I was confident that I could find a use for the leftovers. The trim new Styleline handsets manufactured by Automatic Electric have a Touch-Tone pad built into the handset along with a recall switch. The recall switch can be depressed momentarily to disconnect your call.

I figured I could use the built-in recall switch for push-to-talk. I wouldn't even have to remove the Touch-Tone pad; I could use the entire handset as a microphone. Little did I realize that it wasn't as simple as all that! One of the members of my radio club pointed out that the

This circuit can also be used with a Trimline telephone handset. **editor.**

built-in recall switch should be used for push-to-listen, *not* push-to-talk, since this button is in series with the cradle switch and completely disconnects the handset from the line.

One of the club members had taken his phone apart and mounted a normally-open push-button switch in the handset. He used the dial-light wires already in the cord. But what a job; the handset was so jam-packed that he could hardly get it back together again.

Dismayed but not undaunted, I began to think about solving this problem. Certainly I could activate a relay when I took the handset off the hook. This would turn the transmitter on; when I wanted to listen I could either push the recall button down and hold it, or hang up. The circuit for this arrangement is shown in fig. 1.

When the new Styleline phone arrived a quick examination convinced me that holding down the recall switch to listen — not an easy button to operate — was not the way to go. I didn't even think I wanted to operate it as a push-to-talk switch, trying to hold it down during one of my long-winded transmissions.

I recalled the ordinary dial telephone: When the handset is picked up, a switch connects the telephone to the line. However, when a number is dialed, the line is momentarily broken the same number of times as the number dialed. What prevents line disconnection during dialing? "Delay," I thought to myself. The cradle switch is operated longer (typically much longer) than the dialing pulse mechanism.

I decided I would need two relays: one for control, the other for push-to-talk. The control relay, activated as soon as the handset is lifted from the cradle, would have a fast-operate slow-release characteristic so it would ignore the momentary operation of the recall switch. The push-to-talk relay would be controlled by the recall switch on the handset.

The control relay would provide two functions; when the handset was still on the cradle the relay would insure that the push-to-talk output could not be accidentally triggered, and it would make sure that the control circuit would always go to the receive mode when I hung up

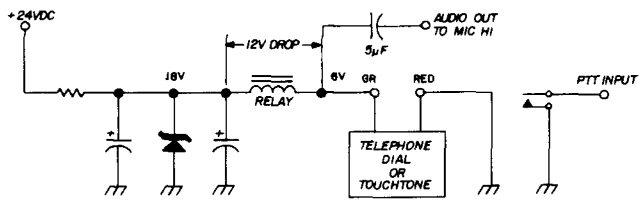


fig. 1. Automatic transmit control for a telephone set.* With this circuit the relay is energized when the handset is removed from the cradle. The relay contacts may be used to turn on the transmitter or activate a vox circuit.

*Styleline telephones are available from Junction Distributors, 164 Cypress Lane, Nashua, New Hampshire, 03060. Styleline Touch-Tone handsets are $39.20; Styleline base, desk type, $13.25; Styleline base, wall type, $12.45; Touch-Tone pad only, $27.20; enclosure for Touch-Tone pad, $6.80. Add $1.00 for orders west of the Mississippi River. Styleline telephones are available in beige, ivory, blue, ebony, green, yellow, avocado, pink and white; the Touch-Tone enclosure is available in either beige or black. Junction Distributors will provide a complete list of telephone equipment upon receipt of a self-addressed, stamped envelope.

the telephone.

In some installations the push-to-talk relay may not be needed. The push-to-talk relay in the transceiver could be driven directly from by the relay-driver transistor. However, be sure to put a diode across the relay coil to shunt transistor-destroying voltage spikes caused by the collapsing magnetic field when the coil drops out.

Since I planned to operate the recall switch as a momentary push-to-talk, momentary push-to-listen button, I needed a memory circuit; a J-K binary would be fine. The binary, actuated by the recall switch, would alternately change state, thereby providing driving logic for the sequential transmit/receive modes of the push-to-talk relay.

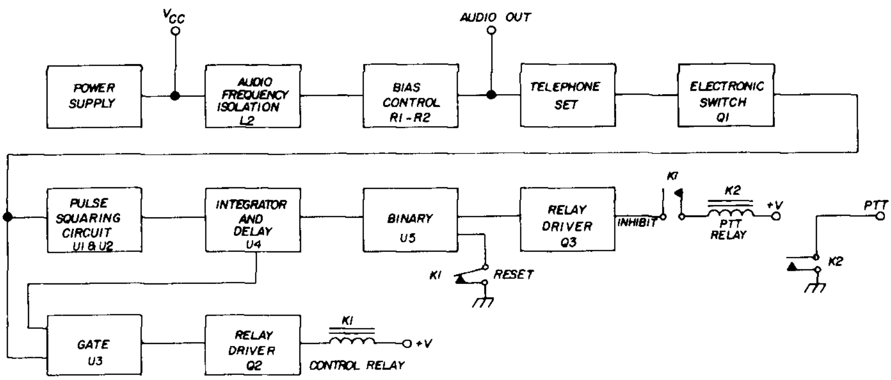


fig. 2. Block diagram of the push-to-talk control circuit. Complete schematic is shown in fig. 3.

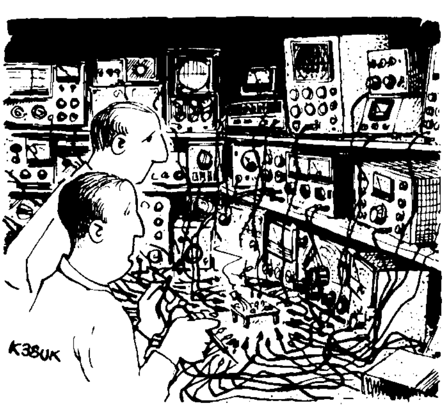
power supply

Several different voltages were available because I was going to use the push-to-talk control assembly at my base station. Although 24 volts dc was available for the relays, instead of dropping this down to +5.0 volts for the integrated circuits, I decided to use a 6-Vac supply and build a small bridge rectifier circuit. This would give me 6 Vdc to operate the Touch-Tone and the carbon microphone in the handset.

If the control circuit is to be used in a mobile station, the +12 Vdc supply can be used with an appropriate voltage-dropping resistor in place of the bridge so that approximately +8 Vdc is available at the input of L1 in **fig. 3**.

All parts for the power supply came out of my junk box. Filtering is quite important since any hum on the power supply lines will show up as hum on the transmitted audio. The chokes I used were pulled out of old tv sets.

The voltage drop across both smoothing chokes must be considered when determining correct values for R1, R2



"As near as I can tell, it was frightened to death . . ."

and R13. The off-hook Styleline requires from 20 to 30 milliamperes of current. The lowest voltage at the input of R4 should not be less than 0.7 volts; otherwise Q1 will respond to audio inputs and cause erratic triggering. R13 is selected so that the power rating of the zener diode is not exceeded.

When I first put the circuit together I intended to put a capacitance delay circuit across relay K1. However, I soon discovered that the recall switch in the Styleline handset had considerable contact bounce. This generated multiple pulses each time it was operated with the result that it was impossible to determine

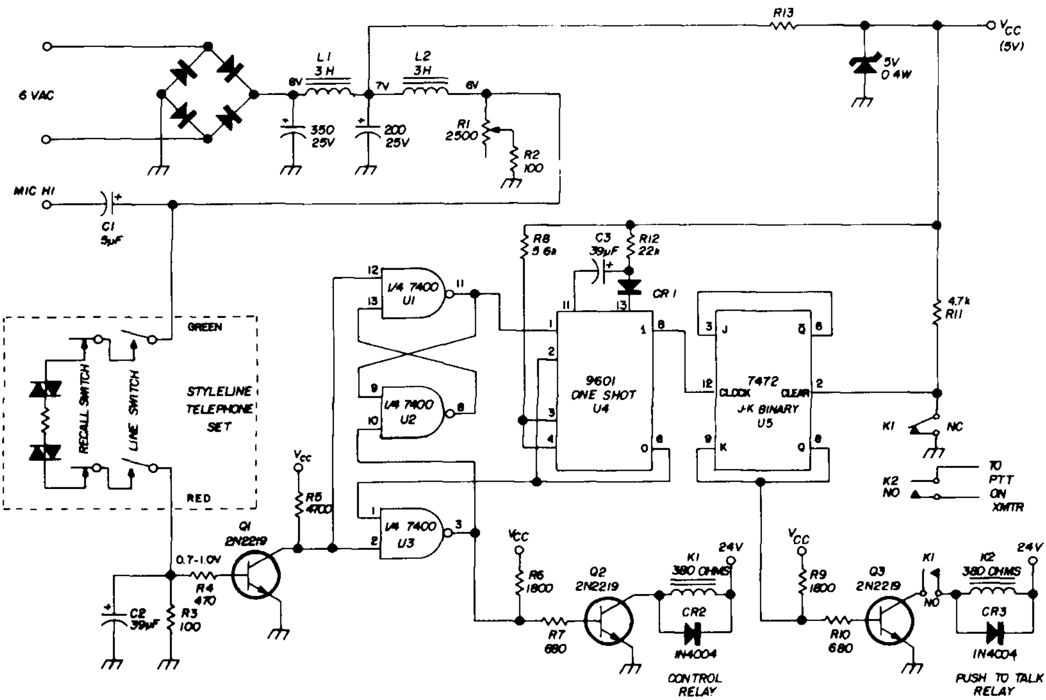


fig. 3. Push-to-talk control circuit for Styleline telephones is activated by the built-in recall switch. Integrated circuits U1, U2 and U3 are part of a Signetics 7400 quad two-input gate. U4 is a Fairchild 9601 monostable multivibrator. U5 is a Sprague 7472 J-K binary.

circuit

Inductor L2 provides additional filtering as well as providing a high impedance to audio signals. Capacitor C2 establishes a low impedance to audio signals across the biasing resistor R3. Both L2 and C2 are essential to the proper operation of this circuit.

I used 2N2219 transistors in the circuit because they were available. Any npn switching transistor that can withstand the relay driving voltage and provide adequate driving gain should work.

the state of the J-K binary. I decided to concentrate on solving the contact bounce problem and worry about relay delay later.

By adding a Fairchild 9601 integrated-circuit one-shot to the circuit and wiring the 0 output back to pin 2, a single pulse was produced at the output although many pulses appear at the input. The one-shot is triggered from a cross-coupled-gate pulse-squaring circuit; the one-shot output provides a clean clock trigger for the J-K flip-flop.

timing

The one-shot timing circuit (C3, R12 and CR1) is critical only to the extent that there is sufficient delay to insure that switch contact bounce has ceased. The delay time of the one-shot circuit can be determined from the following formula

$$T \approx 0.36\ RC(1 + \frac{0.7}{R})$$

where R is in kilohms, C is in picofarads and T is in nanoseconds.

Diode CR1 is used when capacitor C3 is an electrolytic. This diode prevents a reverse voltage across C3. The resistor for this circuit should be less than 30k, and all timing components must be as physically close to the circuit as possible to reduce noise pickup.

The one-shot provides an additional feature that soon became apparent. Rather than adding a delaying circuit across the control relay, the 0 output from the one-shot was used to maintain a holding level for the K1 relay driver during momentary operation of the recall switch. Although a short *off* pulse occurs (see **fig. 4**) it is much too short for K1 to respond.

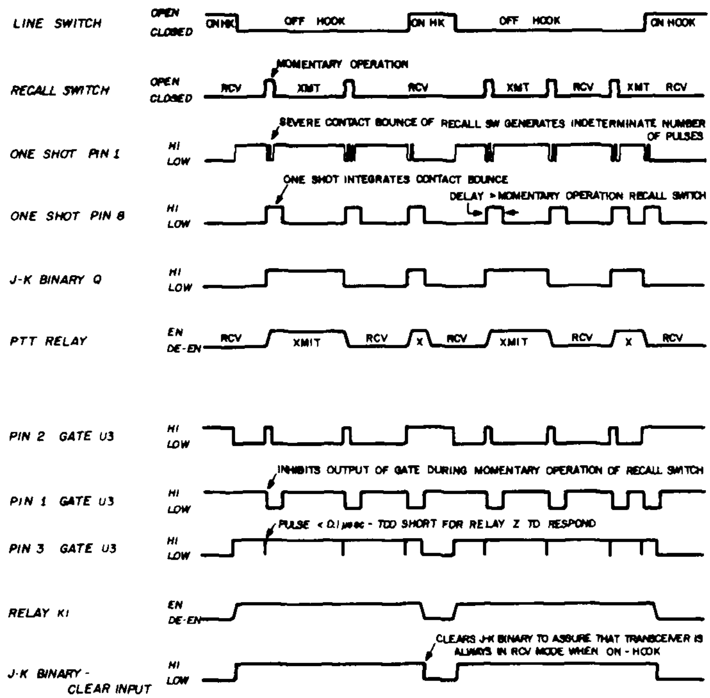


fig. 4. Timing diagram for the push-to-talk control circuit.

summary

I am using the push-to-talk control circuit in **fig. 3** in my base station. When I hang up the Styleline handset the radio is switched to receive and stays in that mode until I pick up the handset and momentarily push the *recall* switch. It works very well, and provides a good deal of satisfaction when I show it off to those disbelievers who said it couldn't be done.

ham radio

More Details? CHECK—OFF Page 120

frequency dividers for ssb generators

A simple frequency-dividing scheme for generating upper- and lower-sideband mixing frequencies for surplus ssb filters

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Some of the mechanical and crystal-lattice filters obtainable from surplus and other sources are not available with the necessary crystals for carrier generation in a ssb exciter. These crystals should be chosen at a frequency 20 dB down the skirt of the filter frequency response. They are fairly expensive if purchased new and surplus crystals are never quite on frequency. Here is a way to solve the problem simply and inexpensively.

The block diagram (in **fig. 1**) shows a method of sideband generation derived from the "Sideband Package" described by W6TEU.[1] It uses only one crystal to generate the necessary frequencies to produce a high-frequency sideband signal that does not shift frequency when changing sidebands. The 500-kHz carrier generator crystal is used to produce a ssb signal at 500 kHz; harmonics of the 500-kHz signal at 1 MHz and 2 MHz are used to heterodyne the 500-kHz signal to 1500 kHz. Upper and lower sidebands are selected by the choice of the 1- or 2-MHz injection frequency in the second balanced modulator.

Fig. 2 shows that the same results can be obtained by using a high-frequency crystal and a system of dividers to get the proper injection frequencies. This circuit has the advantage that a lower-cost more readily available high-frequency crystal can be used; this crystal can be "rubbered" in frequency so that it can be placed on the frequency corresponding to the 20-dB point on the filter curve.

The schematic diagram in **fig. 3** shows a practical circuit I used in my solid-state ssb exciter. The 1500-kHz ssb signal could be used with a 5- to 6-MHz vfo to produce a usable signal on the 40- and 80-meter bands. However, in my case the vfo frequency was chosen to produce a tunable ssb signal between 6 and 6.5

MHz. This signal is heterodyned with crystal-controlled oscillators to get to the desired amateur band.

A little arithmetic will show that similar schemes can be worked out for 1500-kHz amplifier. Small toroid coils should work as well.

The diodes in the balanced modulators were surplus computer diodes and careful matching was not found to be necessary.

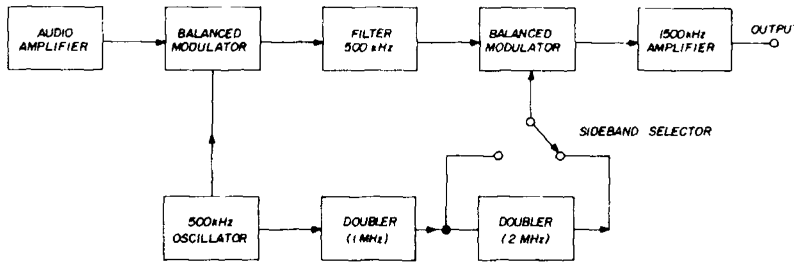


fig. 1. Block diagram of sideband generator derived from the Bigler's Sideband Package.

other filter and heterodyning frequencies by the proper choice of crystal and divider ratios. Integrated-circuit frequency dividers can provide almost any reasonable divider ratio.

construction

The sideband generator was easily built with parts at hand, and no special selection was found to be necessary. Any of the available JK flip-flops should work as well as the μL923s provided proper

The amplifier transistors are biased for class-A operation by proper choice of the resistors in the base circuit. A little instability was detected in the 2N2102 1500-kHz amplifier until the neutralizing circuit was added. This consists of a piece of wire wrapped around, but not connected to, the base of the transistor; the other end is connected to the free end of the plate tank circuit.

The crystal-oscillator circuit worked very well, and its output was sufficient to

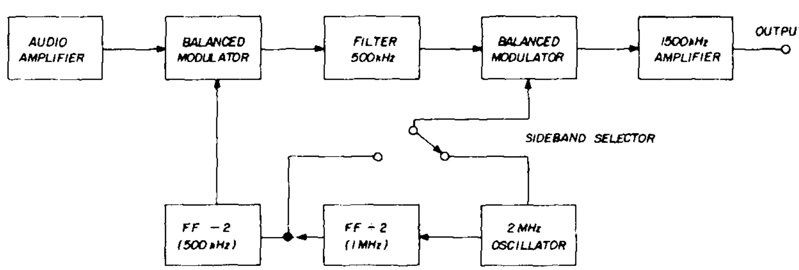


fig. 2. Modified sideband generator circuit uses frequency dividers for generation of upper- and lower-sideband carriers.

connections are made and the toggle frequency is not exceeded. The tuned circuits shown at the outputs of the flip flops were added to filter harmonics of the divider frequencies. These tuned circuits were salvaged from Japanese transistor radios as were the ones in the

drive the first divider and the second balanced modulator without any shaping or amplification.

Other crystals with less activity may require higher voltage on the oscillator to produce oscillation. In this case it may be necessary to limit the drive to the first flip-flop to prevent damaging it.

You may wonder about the particular filter shown on **fig. 3.** While a 4-kHz bandwidth would not be very desirable in a receiver or transceiver, it presents no problem in a simple ssb transmitter because the bandwidth is easily restricted in the audio system. This permits the use of mechanical filters of any bandwidth greater than 2.1 kHz as long as the filters have a steep skirt and desired out-of-band characteristics.

I hope that the ideas presented here will help other amateurs put some of the surplus filters to work in a rewarding homebrew project.

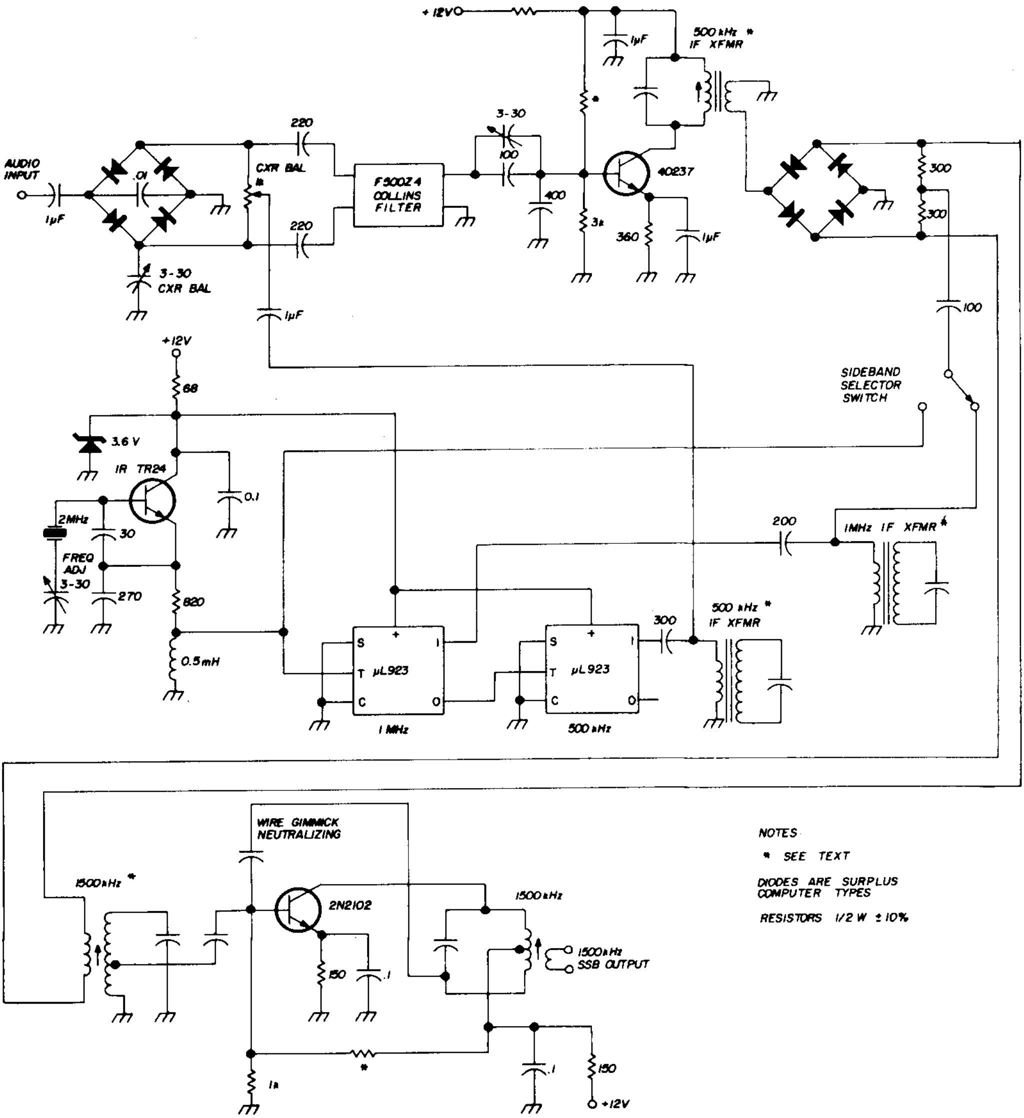


fig. 3. Schematic of the complete ssb package using IC frequency dividers. For components marked with an asterisk, see text. Diodes are surplus computer types.

reference

1. A. A. Bigler, W6TEU, "A Sideband Package," *QST*, June, 1958, page 24.

ham radio

More Details? CHECK—OFF Page 120

general-coverage receiver frequency calibrator

This circuit provides easily distinguishable frequency markers to above 30 MHz

G. Tillotson, W5UQS, 436 Grace Drive, Richardson, Texas 75080

For a number of years my station receiver was a ham-bands-only design. When I developed an interest in world-wide short-wave listening I found the amateur communications receiver too restrictive frequency-wise, so I purchased a medium-priced communications receiver.

The first problem was dial calibration; there were marks for each MHz point, but how did you locate an intermediate point? The usual 100-kHz calibrator was no help. When the distance between the 9- and 10-MHz calibration points is less than 1/8-inch, how do you determine which is the 9.7-MHz marker?

The circuit described here was designed to locate the desired marker. By starting at 1.0 MHz for the main dial marks, and switching to 500 or 100 kHz, it is easy to locate *any* 100-kHz point on the main tuning dial. In addition, this circuit provides strong harmonics well above 30 MHz.

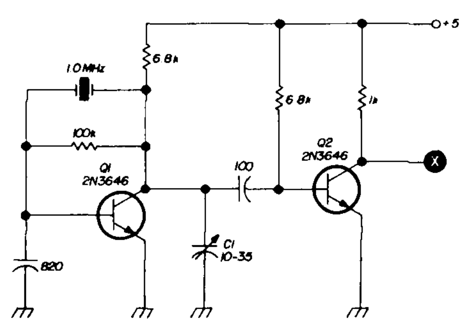
oscillator

The integrated circuit used in the crystal oscillator circuit in **fig. 1** is a hex inverter; three inverter stages are used.

table 1. Operation of the integrated-circuit crystal oscillator.

crystal frequency		no padder	35 pF padder
1.00 MHz	32 pF	—	1.000 MHz
7.68 MHz	32 pF	7678.205 kHz	7.680 MHz
10.00 MHz	32 pF	9994.308 kHz	10.000 MHz
10.00 MHz	series	9997.428 kHz	10.000 MHz
15.36 MHz	32 pF	15339.505 kHz	15.360 MHz

The circuit will work with crystals from about 700 kHz to above 15 MHz as indicated in **table 1.** Variable capacitor C1 provides a means of adjusting the oscillator to precisely the desired frequency.



Alternate transistor crystal oscillator circuit.

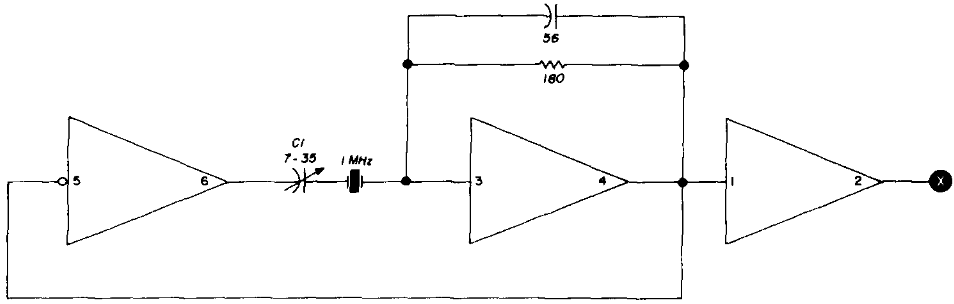


fig. 1. Integrated-circuit crystal oscillator circuit uses hex inverter, Motorola MC3008 or TI SN74H04. Alternate transistor oscillator is shown on page 28.

Since this is a fundamental crystal oscillator circuit overtone crystals oscillate at their fundamental. The output waveform is rich in harmonics. An alternate transistor oscillator is shown on page 28.

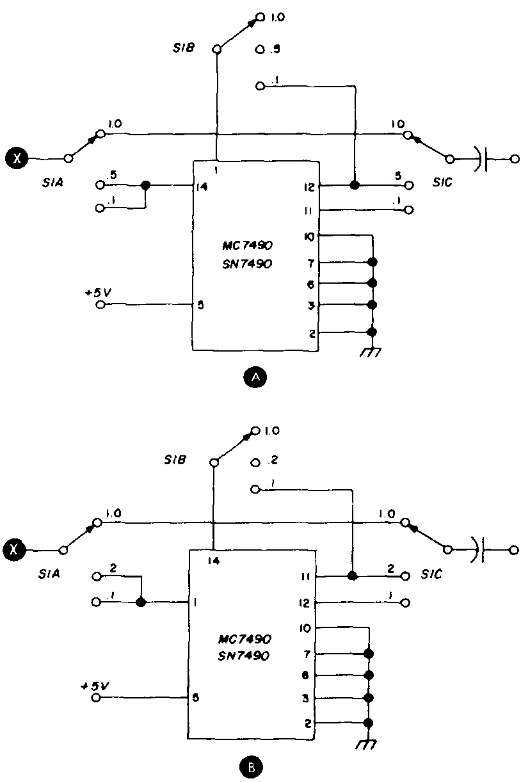


fig. 2. Frequency divider uses TTL integrated circuits. Arrangement in (A) provides output at 1.0, 0.5 and 0.1 MHz, while (B) provides output at 1.0, 0.2 and 0.1 MHz.

The two TTL integrated circuits used in the frequency divider are very fast. The circuit in **fig. 2A** is a divide-by-two section followed by a divide-by-five section.* With the connections shown in **fig. 2** two sets of frequency markers are avaiable, 1000, 500 and 100 kHz (**fig. 1A**) and 1000, 200 and 100 kHz (**fig. 1B**)

construction

The receiver calibrator is built into a small mini-box with switches S1 and S2 (power) located on one end. I used a miniature 3-pole, 3-position lever switch for S1, but a rotary switch could be used. Power is provided by the low-voltage supply in the solid-state general-coverage receiver. A portable supply could be made from three 1½-volt dry cells.

operation

With this circuit I had no problem with the oscillator starting or divider operation with the crystals I tried. The alternate transistor oscillator circuit did require capacitor substitution to get close enough for the trimmer capacitor to set a zero beat with WWV. For highest accuracy the unit should be calibrated against WWV with the divider set to the 100-kHz position.

ham radio

*Other divide ratios can be obtained by internal or external gating. For more information see Texas Instruments Bulletin CA-102, "Counters and Shift Registers."


BASSETT
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integrated-circuit single-sideband speech processor

This high performance speech processing circuit provides more than 4 dB intelligibility threshold improvement with no distortion

Gene A. Nurkka, VK9GN, Box 73, Ukarumpa, E. H. D., Territory of New Guinea

Speech processing is one of the most popular topics for discussion among groups of amateur radio operators. When DXers gather at club meetings, sooner or later the talk turns to speech clippers, speech compressors, rf clippers and alc circuits. This is only natural. When the active DXer has put up the best antenna he can afford, as high as possible, and is using maximum legal power, the only way he can further improve his signal is through some method of speech processing.

Many excellent articles have been written on this subject. I highly recommend that you carefully review the articles listed in the bibliography. W6JES, W1DTY and K1YZW set forth the basic facts of speech processing and indicated that rf clipping is the best system for ssb communications work.[1,2] K6KA clearly shows that background noise must be completely absent when using any type of speech processing.[3] K1YZW shows why simple speech clipping should not be used with ssb equipment.[4]

time constants

In an audio-frequency speech compressor the ideal attack time should be less than 1 millisecond, and the release time should be faster than 10 milliseconds. However, the problem with such short time constants has been distortion which is caused by phase shift within the control loop. With the very complex internal circuitry of the IC used in the speech compressor in **fig. 1** no phase-shift problems are encountered when using even shorter time constants. As long as the release time-constant is longer than several cycles of the speech waveform, there is very little distortion.

performance

The *only* way to evaluate accurately the actual improvement offered by a speech processor is to measure the Intelligibility Threshold Improvement (ITI).

To do this, a test path is set up where the unprocessed ssb signal is just barely understandable in the presence of white noise. The speech processor is switched in and a calibrated attenuator inserted in the line to the communications receiver. Attenuation is increased until the processed ssb signal is again just barely understandable; the value of attenuation is the ITI in dB.

While running ITI tests between my station and the club station, VK9UC, I found that the actual ITI measurement was very subjective: Under the same operating conditions different operators come up with different values for ITI.

The IC speech compressor in **fig. 1** measured approximately 4-dB ITI with 18-dB peak limiting. With this circuit peak limiting can be as great as 28 to 30

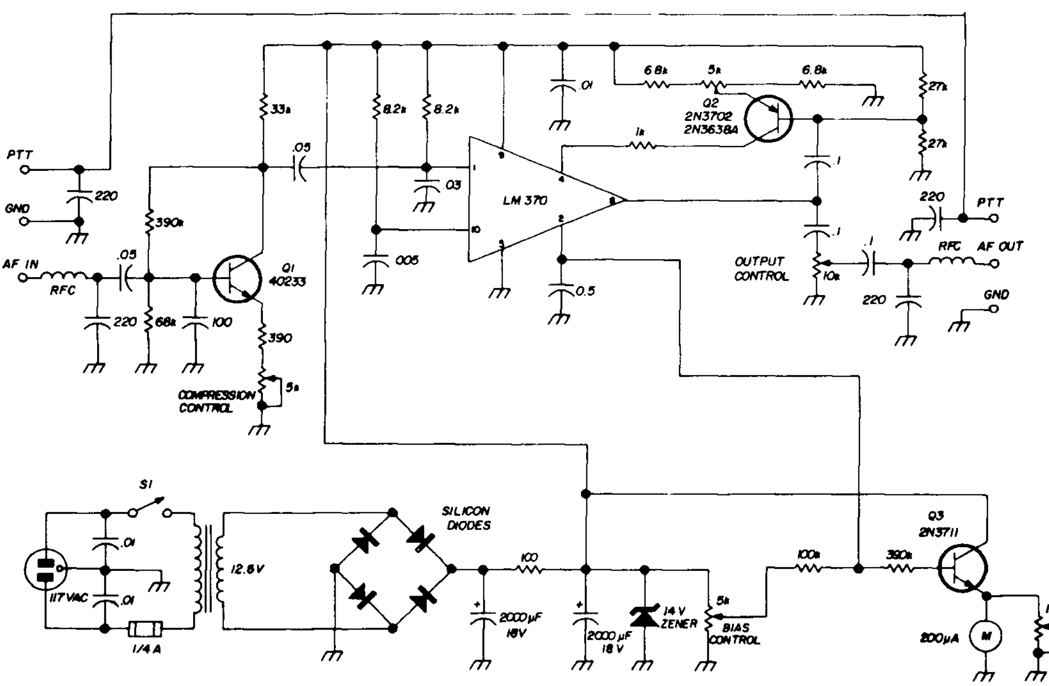


fig. 1. Schematic diagram of the IC audio speech compressor.

dB before objectionable distortion occurs. With ordinary long-time-constant speech compressors ITI is only about 1 dB. After running these tests I feel that many authors are overly optimistic when quoting up to 10-dB ITI with a 20-dB peak-limiting rf clipper.

My reasons for selecting this type of speech processor are ease of installation and adjustment, satisfactory ITI without distortion and low cost. On all of these points the compressor is better than adding an rf clipper to your transmitting setup. Many of the rf clippers I have heard on the air produce noticeably more distortion than this circuit. This may be due to the adjustment and installation problems encountered when adding an rf clipping circuit to an existing ssb transmitter.

circuit

The National LM170, LM270 and LM370 are a family of IC amplifiers with built-in agc systems.* For amateur use the LM370 is completely adequate; the LM170 and LM270 are more expensive devices that have tighter operating specifications and extended temperature ranges.

The LM370 amplifier circuit, built into a TO-5 transistor package, contains 34 transistors and 20 resistors.

Transistor Q1 in **fig. 1** is used in a low-noise, low-gain stage which amplifies the microphone input slightly to drive the LM370 IC into its compression range. The 5k *compression control* is a variable emitter resistor which controls the gain of the stage. This effectively varies the amount of compression; maximum resistance coincides with minimum compression.

The input impedance of this stage is sufficiently high for use with high-impedance microphones. I normally use a low-output 200-ohm dynamic microphone, and there is sufficient range to provide plenty of compression.

The input, output and power leads are filtered for rf as are the base of transistor Q1 and pins 1 and 10 of the LM370 integrated circuit. The 0.03-μF capacitor connected to pin 1 of the IC provides some roll-off for high audio frequencies.

The 0.5-μF capacitor from pin 2 to ground determines the attack and release times of the circuit. Attack time is approximately 0.5 millisecond, and release time is about 10 milliseconds. I found during compression that there was quite a bit of negative-peak distortion due to charging this capacitor to 1.5 volts (see

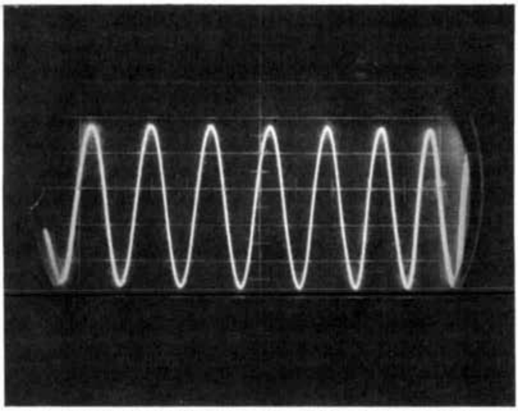


fig. 3. By biasing pin 2 of the LM370 IC at +1.5 volts, there is no negative-peak distortion at 18-dB compression.

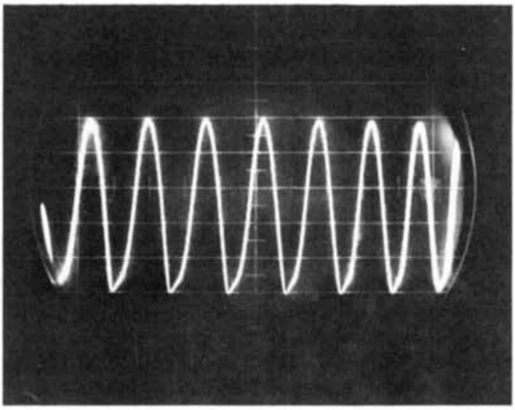


fig. 2. Negative-peak distortion with 18-dB compression (see fig. 3).

fig. 2). When the voltage on pin 2 is less than +1.5 volts, there is no compression, so I biased the capacitor to about the +1.5-volt level. This completely cleared up the distortion as shown in **fig. 3.**

Since the voltage on pin 2 is related to the compression level I added a dc amplifier (Q3) and a 200-microamp meter as a compression indicator. To set up the meter circuit, disconnect the 390k resistor from pin 2 and connect it to +1.5 volts dc. Adjust the 1000-ohm potentiometer until the meter reads some convenient level about two-thirds full scale. Reconnect the 390k resistor to pin 2.

Now, with the compressor on, but with no input signal, adjust the 5k *bias control* until the meter reads to the same two-thirds point or slightly less. This reading will drift slightly with ambient temperature changes. This is all right as long as the meter does not go over the two-thirds point (pin 2 not over +1.5 volts).

In normal operating the meter will flick somewhat higher with compression. The higher the meter reading, the greater the compression; with no movement of

*The LM170, LM270 and LM370 agc/squelch amplifier integrated circuits are manufactured by National Semiconductor Corporation, 2975 San Ysidro Way, Santa Clara, California 95051. The LM370 is priced at $4.50 in small quantities.

the needle, there is no compression although the unit still operates as a preamplifier. Some high-output microphones will produce occasional voice peaks which will be compressed even with the *compression control* turned fully down.

Transistor Q2, along with the internal circuitry of the IC, provides detection of the negative audio peaks. There is no current flow through Q2, and no compression, until the negative voice peaks exceed a certain level.

The base of Q2 is biased to one-half the supply voltage. The emitter voltage is set with the 5k potentiometer to provide an output from zero to several hundred millivolts. If this pot is set too near the zero-output point a severe transient pulse appears at the output of each syllable. Other than this the setting, this potentiometer is not critical. With the wiper of the 5k pot set at its lower end you will obtain maximum output and a compression range of about 28 dB.

If you have an oscilloscope and an audio signal generator you can experimentally check various settings of this 5k emitter potentiometer. I have found that there is one point where you obtain maximum overall compression range before distortion occurs, and this varies from one LM370 to another. The improvement in compression range in only a matter of a few dB so it may not be worth the effort.

Since the circuit requires about 13 mA I included a simple ac power supply rather than using batteries. When I first built the unit I used batteries, but I often forgot to turn the compressor off when I closed down the station, and in only a few days the batteries would be dead. If you're only going to use the compressor for amateur communications (I also use mine when tape recording speech) the +14 volts may be taken from your transmitter power supply. The zener diode is not really necessary and may be left out, although the supply voltage will increase slightly.

My compressor is built into a small metal cabinet as shown in the photographs. Two printed-circuit boards, shown in **fig. 4**, are used. One circuit board contains the IC-compressor circuit; the other holds the final filter capacitor and metering circuit.

operation

When my wife and children, with their high-pitched voices with many peaks, speak into the microphone, the compressor is worth its weight in gold. With a normal male voice the compressor provides at least 4 dB improvement. Although this is substantial it is *not* going to make you top dog in the DX pileups. Although your peak power remains the same, a 4-dB improvement in peak to average power ratio is approximately equivalent to increasing your transmitter power from 100 to 250 watts.

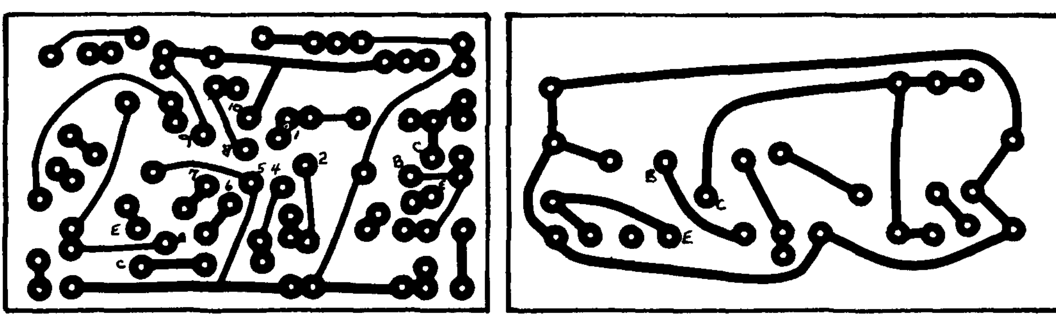
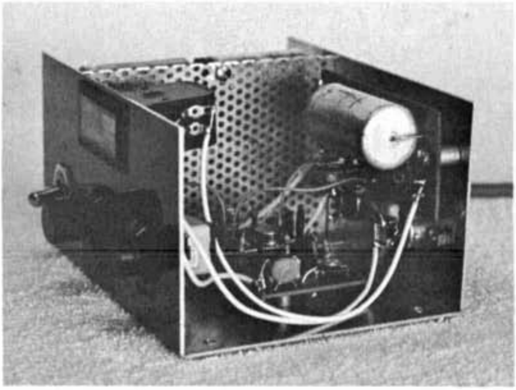


fig. 4. Full-size printed-circuit boards for the speech processor. Board on left contains IC and associated components; board on right holds final filter capacitor and meter circuit.

If your transmitter power supply sags with this higher output power the speech compressor will not provide much on-the-air improvement. Also, if your transmitter uses tv sweep tubes in the final



Construction of the speech processor. Power supply is located behind the shield.

amplifier you will probably be replacing them more often because the higher average power will result in greater heat dissipation and shorter tube life. This is where the *compression control* and meter come in handy; when signals are good I usually run the compressor so the meter only occasionally flicks upward, indicating occasional compression of voice peaks. This gives maximum tube life and prevents overdrive and splatter.

When my wife and children are talking I use more compression, and they get through solidly. When signal conditions are bad, or rare DX appears, I use maximum compression to provide maximum talk power.

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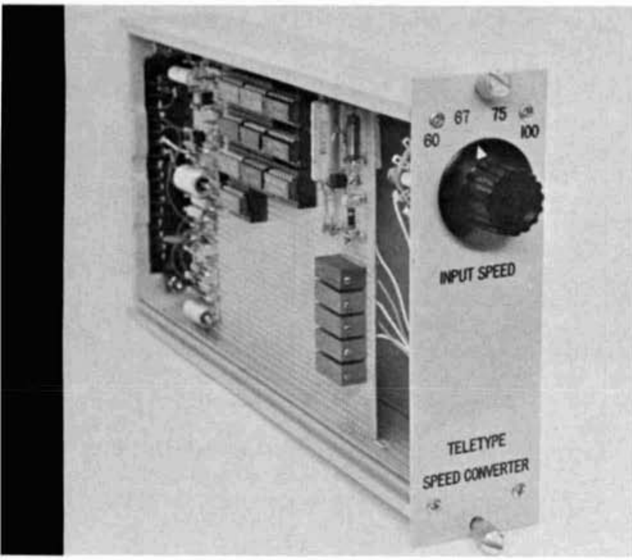


electronic speed conversion for RTTY teleprinters

A reliable and accurate alternate for gearbox speed translators is this converter using ujt clocks and IC counters

Laurence H. Laitinen, WA6JYJ

Many RTTY operators are interested in using their teleprinters at speeds higher than 60 wpm for activities such as punching tape (e. g., operating a model 19 teleprinter* at 75 wpm to obtain hard copy while punching), MARS work, snooping around the commercial frequencies for press copy, or for possible multi-speed operation in the amateur bands should a current proposal before the FCC be adopted.[1]

Such operation requires at least two machines, one operating at 60 wpm and another for higher speeds. If more than one higher speed is of interest, more machinery will be needed. Most RTTY operators use the higher speeds only occasionally so the high-speed machines are idle most of the time. Even with

*This equipment and other RTTY gear is discussed in "First Steps in RTTY" by Chuck Schecter, W8UCG, which appeared in the June, 1971 issue of *QST.* **editor** multiple-speed authorization, 60 wpm will probably be the predominant RTTY speed, since most machines currently in use operate in this range.

Owners of model 28 machines may use a gearbox to print at two or three different speeds – if their pocketbooks can stand it. However, such items are expensive and hard to come by through surplus sources.

An alternate approach, suggested by W6JVE, is to use electronic speed conversion. A few years ago this method would have been impossible. Today, ICs and other sophisticated solid-state devices make electronic speed conversion easy and relatively inexpensive. In the converter shown here, only 10 ICs and 7 transistors are used (excluding those in the power supply).

operation

The logic diagram of the speed converter is shown in **fig. 1.** Its input is connected to a terminal unit and the output to a model 28 printer operating at 100 speed (a model 15 may be used at 75 speed).

The speed converter receives slower-speed teleprinter signals and temporarily stores each character (one at a time) in a shift register. It then makes a parallel transfer to the output shift register and transmits the character to the model 28 printer at a 100-wpm rate. While the speed converter is transmitting the character to the model 28 printer, it is ready to receive another character. The receiving speed can be anything less than or equal to the converter output speed. Speed selection is by a switch that changes the timing resistance in the receiving section unijunction oscillator clock.

In addition to the speed-converted output, an additional output is provided that is equal to the receiving speed. This output is a regenerated replica of the input signal and can thus be used for bias-free retransmission.

Transistor-transistor logic is used throughout. The shift registers are five-bit registers (on one chip) plus a single type-D flip-flop to make the registers six bits long. The receiving section counter is composed of four type-D FFs. The original speed converter used a four-bit dtl counter when ttl prices were relatively high. Now, at the physical expense of another chip package, it's cheaper to make the counter from discrete FFs.

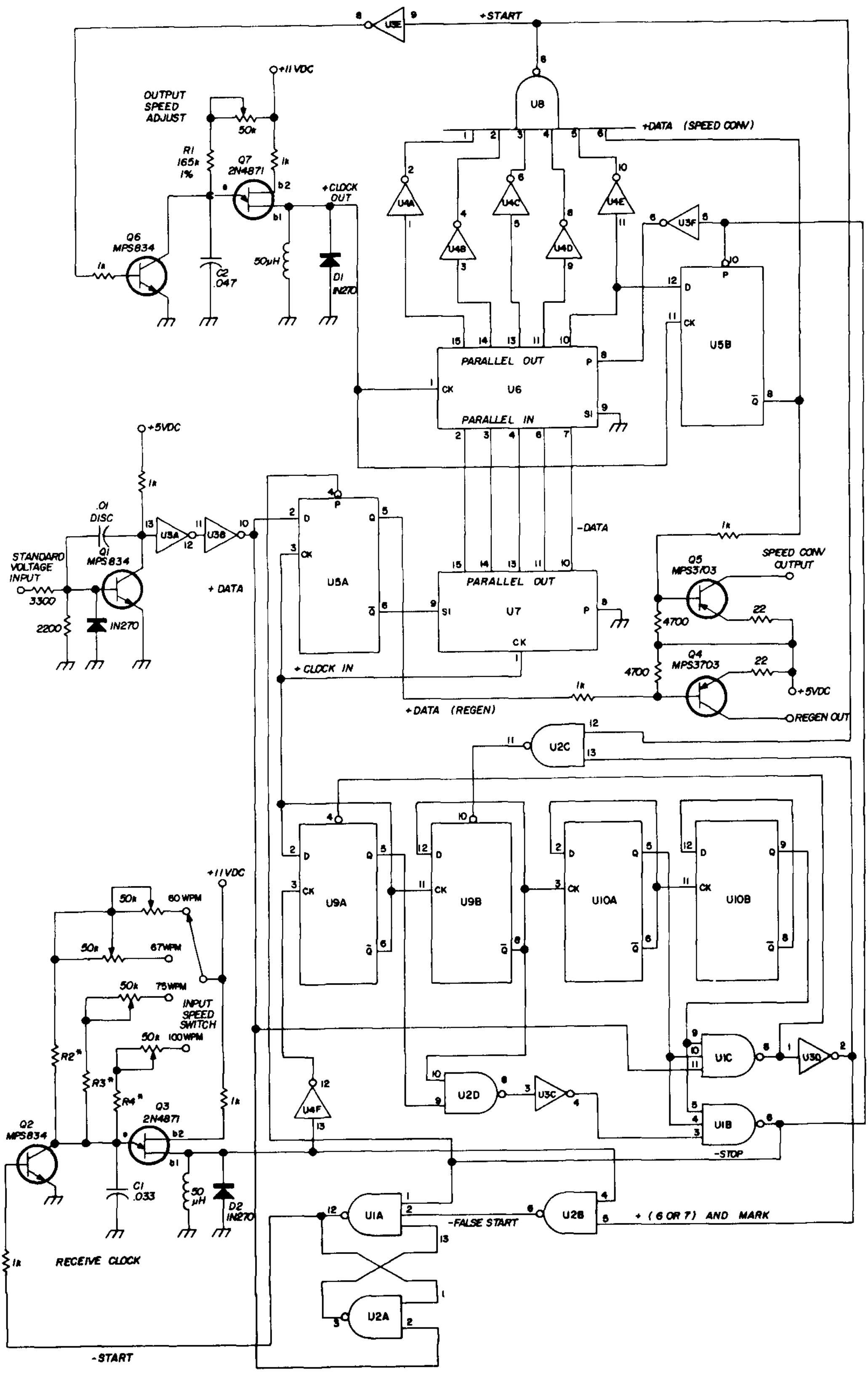
The input section consists of W6JVE's standard voltage interface.[2] (Alternate arrangements are shown in **figs. 2A** and **2B.**) Since the standard for mark and space is a negative and positive voltage level respectively, the output of Q1 is +mark and is thus labeled +data. The input impedance of TTL logic is fairly low, so Q1's output is buffered by inverters, two of which are necessary to preserve signal sense.

The input of the six-bit receiving shift register is half of a 7474 dual type-D flip-flop. This ff provides the regenerated output signal at the same speed as the incoming signal. Thus, its noninverted (Q) output is connected to the standard voltage interface output circuit. Although not shown, Q4's collector is returned to a negative voltage source through the standard voltage interface hub. An alternate output arrangement is shown is **fig. 2C.**

receive clock

The receiving shift register clock is controlled by a latch composed of cross-coupled 3-input and 2-input NAND gates (IC-1A, IC-2A). During a start pulse (space), +data goes low setting the latch and thus turning off Q2, the control transistor for the ujt clock, Q3. The timing capacitor, C1, now charges to the firing point of Q3 through one of the switch-selected timing resistor combinations. The period of oscillation is set to twice the Baud rate by the network RC time constant (see **table 1**).

The 50 μH choke in the base-1 lead of



+START
U3E
U8
OUTPUT
SPEED
ADJUST
+11 VDC
50k
R1
165k
1%
Q7
2N4871
+CLOCK
OUT
+DATA (SPEED CONV)
U4A
U4B
U4C
U4D
U4E
U3F
Q6
MPS834
C2
.047
50μH
D1
IN270
D
P
CK
U5B
PARALLEL OUT
U6
PARALLEL IN
SI
+5VDC
.01
DISC
U3A
U3B
STANDARD
VOLTAGE
INPUT
Q1
MPS834
3300
2200
IN270
+ DATA
U5A
-DATA
U7
SPEED CONV
OUTPUT
Q5
MPS3703
4700
22
Q4
MPS3703
+ CLOCK IN
+DATA (REGEN)
REGEN OUT
U2C
U9A
U9B
U10A
U10B
60 WPM
67WPM
75WPM
100WPM
INPUT
SPEED
SWITCH
R2*
R3*
R4*
Q3
2N4871
U1C
U3D
U4F
U2D
U3C
U1B
-STOP
Q2
MPS834
C1
.033
50
μH
D2
IN270
U1A
-FALSE START
U2B
+ (6 OR 7) AND MARK
U2A
RECEIVE CLOCK
-START

Q3 provides an output pulse width of approximately one microsecond. The 1N270 diode prevents the output from going negative after Q3 turns off.

counter

Since the receiving clock oscillation frequency is twice the Baud rate, the first pulse out of Q3 occurs halfway into the start pulse (11 ms for 60-speed reception). This pulse is applied to the counter (U9, U10) through an inverter so that the counter toggles to 0000 (previously 1111) on the falling edge of Q3's pulse if the received signal is still spacing. (Note that the 7474 ff is positive-edge triggered.) If the signal is not spacing at this time, the counter is inhibited from toggling, and −false start resets the latch. Assuming it is spacing, the first stage of the counter divides the output frequency of Q3 by two and provides clock pulses to the shift register. The inverted ($\overline{Q}$) output of the first counter stage goes from low (0) to high (1) half a bit-time into the start pulse and thus provides +clock-in to the shift register. After the clock pulse rises the data at the input of ff U5A shifts to its output. The input data is now free to change without affecting flip-flop output. The start pulse is now briefly stored by this flip-flop.

The operation above repeats for all five selecting pulses and the stop pulse of the incoming character. Each positive transition of the clock pulse shifts the data one stage to the right. Since the start pulse isn't needed in the speed-conversion process, the start pulse is allowed to shift out of the right end of the shift register so that the five selecting pulses are stored in the five-bit shift register, U7. Note that the input to U7 is from the inverted ($\overline{Q}$) output of ff U5A; thus the parallel

fig. 1. Speed converter logic diagram. The value of C2 is for output speed of 100 wpm (see table 1 and text). Except as noted all resistors are 0.25 watt, 10% tolerance. Capacitors C1 and C2 are 100-volt Mylar, 10%. Capacitor values shown may require up to 5000 pF of padding due to a wide variation in unijunction transistor characteristics and capacitor tolerance (see text).

table 1. Timing resistor values for various speed and Baud rates.

speed and Baud rates	input clock frequency	resistors*
60 speed 45.45	90.90 Hz	R2 = 174
67 speed 50.00	100.0 Hz	R2 = 174
75 speed 56.67	113.3 Hz	R3 = 147
100 speed 74.2	148.4 Hz	R4 = 110

Output clock frequency = Baud rate of desired output speed. Select C2 for desired output speed (e.g., 100 wpm, C2≈0.047 µF; 75 wpm, C2≈0.062 µF).

*1% tolerance

output of U7 is −data. The stop pulse is stored in ff U5A, which provides the stop pulse for the regen output.

sequencing

Each clock pulse from the first stage of the counter increments the last three stages of the counter by one. (We'll ignore the first stage of the counter for counting purposes since the first stage is not in decoding but only for the shift-register clock pulses.) The output of U1B (−stop) resets the clock control latch when the counter reaches 6 (110 counted from right to left in the counter). This normally occurs during the stop-pulse interval. Q2 is turned on by the reset latch, and thus the receive clock is inhibited from producing further output.

If it were not for gate U2D and inverter U3C, U1B would see a count of 6 when the counter turns to 0000 at the beginning of the receiving cycle when the first clock pulse is produced. This is due to the nonzero propagation delay of the counter ffs. Thus U2D inhibits the brief glitch that results when the counters turn to 0000 by first inputing a low signal to U2D several nanoseconds before U9B reaches 0. Note that U9B reaches 0 while U10A and U10B are still 1, and thus a false count of 6 is produced. U2D prevents this false count from reaching the 6 decode gate, U1B. When the counter actually toggles to a count of 6 U2D allows this count to pass to the decode gate, since the first ff is set to a 1 (with the signal line marking during the stop interval). If the signal line is not marking, the next clock pulse will toggle the first flip-flop to a 1.

Thus the receiving portion of the speed converter stops during the stop-pulse interval regardless of whether the stop pulse is present. Such action is quite unlike a mechanical selector, which keeps operating if the stop pulse is missing, leading to synchronization problems.

We now have received the character, and the next step is to transfer it to the output register and reset the counter for the next receiving cycle.

At this point assume that a normal stop pulse is present. U1C detects +mark (from the +data line) AND +6 causing its output to go low, which presets the first stage of the counter to a logical 1.

The second stage of the counter is preset by a race pulse initiated by the -stop signal as follows: The low -stop signal presets the last stage of the output shift register (U5B). The ($\overline{Q}$) output of U5B goes low, which causes the output of U8, an 8-input (only 6 used) NAND gate, to go high. This signal, +start, is ANDED together with +6 AND mark from U1C and U3D to preset the second stage of the counter to a logical 1. This completes the race loop, since the ($\overline{Q}$) output of the counter's second stage is now low, and the count is seven thus causing the output of the six decode gate, -stop, to go high, which is where the race started.

The speed converter receiving section is now ready to receive another character, since the -stop signal has been removed from the latch, and the received character stored by the input register has been loaded into the output register for transmission.

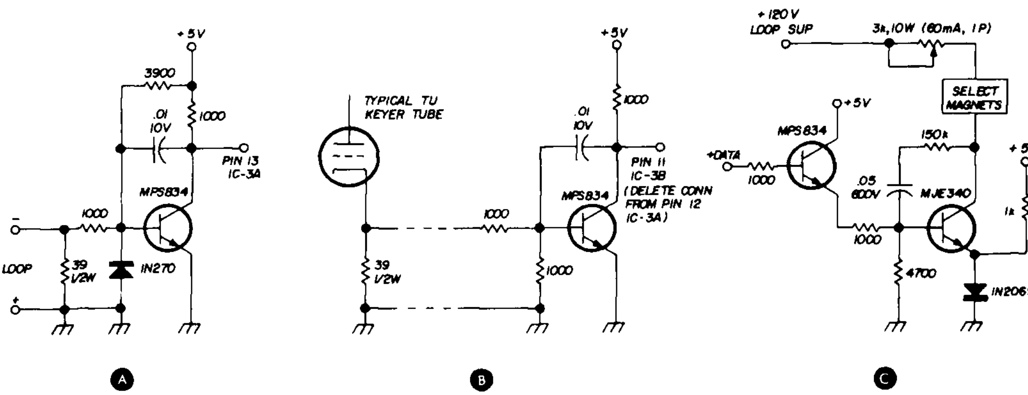


fig. 2. Alternate input circuits are shown in A and B; an alternate output circuit appears in C.

output circuit

The method used to control the output-section clock is to detect space signals in the register and keep the clock on until all spaces have been shifted out. Even if the received character is a *Ltrs* function, one space will be present because the ($\overline{Q}$) output of U5B is low as a result of the race pulse. This low output provides the start pulse and also turns on the unijunction oscillator clock by causing a high on the +start line. In the case of a *Ltrs* function, only one clock pulse is generated. The pulse occurs approximately 13 milliseconds (for 100 speed) after U5B has been preset by the race pulse. The clock pulse shifts the data one stage to the right and shifts in a -mark at the left end (serial input is grounded, thus -mark).

When the start pulse has been shifted out the right end all the inputs to U8 are high, which causes +start to go low, and the clock turns off. If the character K had been received, for example, a space pulse would have been loaded into the first and the last stage of the output shift register. The space pulses move one stage to the right after each clock pulse until the last pulse is shifted out. At this time the clock is turned off because all the inputs to U8 are high.

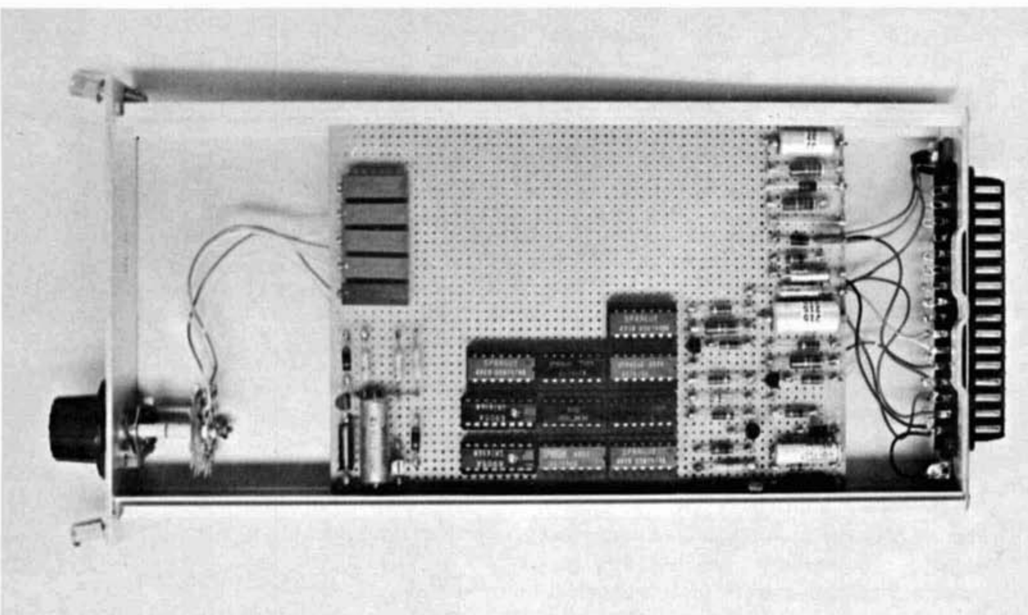
The output cycle is now complete and ready to receive another character from the input section.

construction

The ICs, transistors, and other discrete components were mounted on type 169P59/047 Vectorboard. Sockets can be used to mount the ICs but aren't necessary. The pins of the ICs can be pushed through the holes in the board and the interconnection wires soldered directly to them. Use Vector T-42-1 Micro-Klips to mount the discrete components.

All npn transistors are Motorola MPS834 or equivalent. Diodes D1 and D2 must be germanium — 1N270s are preferred. Silicon diodes cannot be used because of their high voltage drop, which allows the unijunction oscillator output to go too far negative when it turns off. Q4 and Q5 are Motorola MPS3703 or equivalent pnp transistors.

Although the noise immunity of TTL logic is better than RTL logic, TTL generates a bit more noise. This is especially true of the shift-register chips. It's a good idea to solder 0.01-μF disc ceramic bypass capacitors between the V_{ee} and V_{cc} pins of the shift register chips to prevent their noise pulses from being distributed to the other chips.



Internal parts arrangement of the RTTY speed converter. I used sockets, but the ICs could have been mounted directly on the Vectorboard with the leads pushed through the holes in the board.

A suitable power supply is shown in **fig. 3.** Be sure to insulate the 2N4921 from the heat sink (chassis) with the mica washers supplied with it. Verify that the power supply is working correctly before connecting it to the logic.

Five-percent resistors were originally used in the timing networks of the unijunction oscillators. However, considerable improvement in long-term stability was found through the use of one-percent precision resistors. Stability on the order of one or two Hz over a period of several months has been obtained with precision resistors and ten-percent mylar capacitors. Unlike resistors, the tolerance of mylar capacitors doesn't appear to be an indicator of their stability.

initial operation

Before applying power check the speed converter for wiring errors. This doesn't take much time and can eliminate a lot of problems that might otherwise be hard to track down.

If a frequency counter is available, connect it to the base-1 lead of (Q7). Ground the base of Q6 and adjust the associated pot for a frequency of 74.2 Hz for 100-wpm operation (56.7 Hz for 75 wpm).

Due to a wide variation in unijunction transistor and capacitor tolerances, the value shown for C2 is minimum. It may be necessary to pad C2 with a few thousand pF to place the desired clock frequency in the center of the output pot's range. If a counter is not available, use a calibrated oscilloscope. Lacking this, temporarily remove the preset input to U9A (pin 4), ground the base of Q2 instead of Q6, place a mark signal on the input of the converter, then slowly turn the pot until the receiving machine prints *Ltrs* and then something other than *Ltrs* function. Place the pot midway between these two points. Remove the ground from Q6 if still present and replace the preset input lead to U9A if removed.

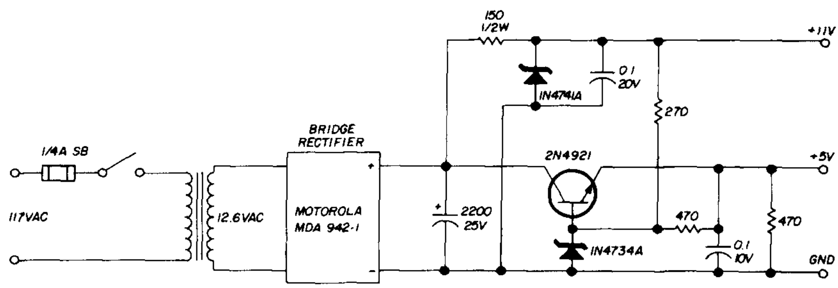


fig. 3. Suggested power supply. The 2N4921 transistor is bolted to the chassis (use mica insulating washers).

receive clock adjustment

The receiving clock frequency should equal twice the Baud rate of the selected receiving speed. Place the input-speed switch to the 60-wpm position, ground the base of Q2, and adjust the 60-wpm pot for 90.0 Hz at base-1 of Q3. Set the speed switch to 67 wpm and adjust the 67-wpm pot for 100.0 Hz. Capacitor C1 may require some padding to get the 60- and 67-wpm clock frequencies to fall within the range of their respective pots. After this, the pots for 75 and 100 wpm may be adjusted for their respective clock frequencies.

If an oscilloscope or counter is not available, the receiving clock can be adjusted by printing a teleprinter test signal of the desired speed. The test signal should be at machine speed. At first the printer may print garbage because the clock is too far out. Carefully adjust the appropriate pot until the printer prints correctly. Find the minimum and maximum points of the pot that give good copy, then carefully center the pot between these two points. (Note: Neither control transistor's base should be grounded with this method.)

If a frequency counter isn't used to adjust the output clock frequency, the adjustment should be refined by making range measurements on the printer. Readjust the output clock frequency for maximum printer range while receiving a test signal.

troubleshooting

Be sure the wiring is correct. It's sometimes helpful to have a friend double-check the wiring – you may consistently overlook a mistake.

The unijunction oscillators should free-run whenever the base of the associated control transistor is grounded. If not, check the base-2 supply voltage. Check the voltage across the timing capacitor; it will resemble a sawtooth waveform when the oscillator is running. The oscillator may not be working due to an open charge path to the capacitor, or the capacitor may be leaky. Check the control transistor by lifting its collector lead from the unijunction emitter.

If the speed converter works only partially chances are one or both clock oscillator frequencies are not correct. Recheck them. Also check the input waveforms – the output of Q1 should be no more than 0.3 volt for a space and greater than 2.5 volts for a mark.

Is the regen output working correctly? If so, the receiving portion of the speed converter is working correctly. If not, check the various logic signals with an oscilloscope.

If the trouble appears to be in the output section, check to see if the clock comes on at all right after a character has been received. If the input of the speed converter is spacing, the speed-converted output should also be spacing (running open). If not, the last stage of the shift register is not being preset or its ($\bar{Q}$) output is not connected to U8. The clock should definitely run when the last stage is preset.

Check the logic levels to the output (hub driver) transistor.

If certain bits are consistently garbled there may be trouble in loading the output register.

conclusion

Operation of the speed converter has been quite reliable. At the beginning of the project it was feared that the unijunction clocks wouldn't exhibit sufficient long-term stability and that crystal clocks with dividers would be in order. Such is not the case – the unijunction clocks have been quite stable with precision resistors and mylar capacitors in the timing networks.

Printing accuracy of the speed-converted machine is not much different than that of a machine geared to the desired speed under adverse receiving conditions. Oftentimes copy is better on the speed-converted machine than on the directly geared machine, probably due to the improved synchronization of the converter's receiving section to the incoming teleprinter signal.

With the possibility of multiple-speed authorization by the FCC for the amateur bands, the speed converter should be a valuable asset to any RTTY station. By suitable transistor switching, the receiving speed of the converter may be changed by control signals from an electronic character recognizer or a stuntbox to allow any of the standard speeds to be programmed into the converter by the received signal. Alternatively, suitable logic could be added to recognize what speed is being received and then change the receiving speed of the converter to that of the incoming signal.

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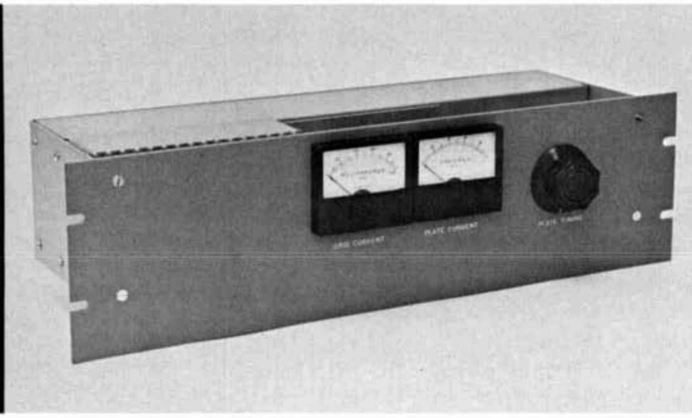


high-power linear amplifier for 220 MHz

This high-performance kilowatt amplifier for the 1¼-meter band uses a new ceramic/metal triode, the Eimac 8874

Robert I. Sutherland, W6UOV, Eimac Division of Varian, San Carlos, California

The Eimac 8874 is a new ceramic/metal, high-mu triode rated for use up to 500 MHz. Operation of this tube in separate 144, 220 and 432 MHz amplifiers has proved that it is an excellent performer up to 450 MHz. This article describes a 220-MHz linear amplifier that uses the 8874.

The 8874 has good division between plate and grid current and low intermodulation distortion. The tube has a plate-dissipation rating of 400 watts and mu of approximately 160. The cathode is indirectly heated, and filament requirements are 6.3 volts at 3.2 amperes.

The 220-MHz amplifier described in this article is designed for the serious DXer who works tropo-scatter as well as for the very serious experimenter who is trying to work moonbounce or meteor-scatter. The compact amplifier uses a grounded-grid circuit with a half-wave open plate line and lumped T-network cathode input circuit. The amplifier is not touchy in operation, requires no neutralization and is completely stable and free of parasitics.

The amplifier is intended for 50 per cent duty operation at the 1000-watt dc input level and can develop 1000 watts

PEP input for ssb operation.* For 1000 watts PEP input the plate voltage should be 2000 volts. The plate current under key-down conditions will be 500 milliamperes. Without speech processing the plate current for one kilowatt PEP input under voice conditions will be about 200 milliamperes. Do not *talk* the amplifier up to 500 milliamperes on ssb! If you do, the amplifier will be overdriven and will cause splatter and distortion. The amplifier will deliver 580 watts output; drive power will be 29 watts. Stage gain is 13 decibels at an amplifier efficiency of 58 per cent.

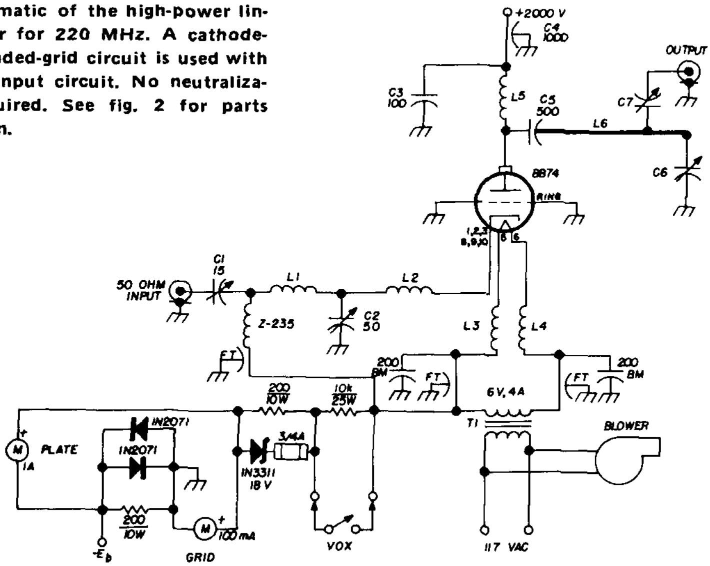


fig. 1. Schematic of the high-power linear amplifier for 220 MHz. A cathode-driven grounded-grid circuit is used with a T-match input circuit. No neutralization is required. See fig. 2 for parts identification.

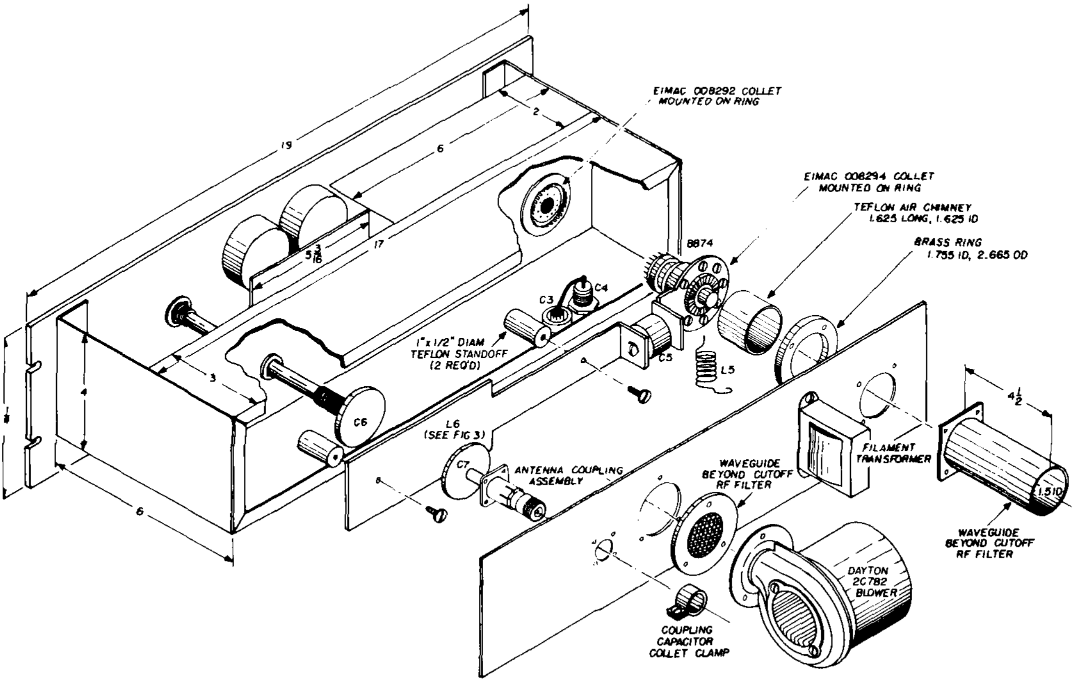
input circuit

The cathode input matching circuit is a T-network which matches a 50-ohm termination to the input impedance of the tube (about 94 ohms in parallel with 27 pF). The network consists of one series capacitor and two series inductors with one shunt capacitance. Electrically, the network has two inductive reactances in series with a shunt capacitive reactance. The variable capacitor, C1, is in series with L1 (see **fig. 1**) to allow the input inductive reactance to be varied. L1 is larger than the network calculations call for; by placing a variable capacitor in series with L1 the correct value of inductive reactance can be obtained by varying

table 1. Performance data. The conditions most suitable for amateur ssb at 1000 watts PEP and 100 watts cw are as follows:

Plate voltage	2000	V
Plate current (idling)	20	mA
Plate current (single tone)	500	mA
Grid voltage	-12	V
Grid current (single tone)	73	mA
Power input	1000	W
Power output	580	W
Efficiency	58	%
Drive power	29	W
Power gain	13	dB

*For a discussion of the ratings for this type of operation read the article, "Intermittent Voice Operation of Power Tubes," in *ham radio,* January, 1971, page 24.



C1	15-pF variable (Hammarlund MAPC-15)
C2	50-pF variable (Hammarlund MAPC 50)
C3	1000 pF, 2500 volts (Erie 1270-010)
C4	100 pF, 5000 volts (Centralab 850S-100)
C5	500 pF (Centralab 858S-500)
C6	1.75" diameter disc approximately 0.4" from plate line.
C7	1.50" diameter disc approximately 0.375" from plate line
L1	0.8 μH, 4 turns no. 14, 5/16" diameter, ½" long
L2	0.03 μH, 1 turn no. 14, ½" diameter, ½" long
L3,L4,	10 turns no. 16 Formvar, 5/16" diameter
L5	10 turns no. 14, 3/8" diameter, 7/8" long
L6	see fig. 3
T1	6 volt, 4 amp filament transformer (Stancor P6376)

Blower is Dayton 2C782

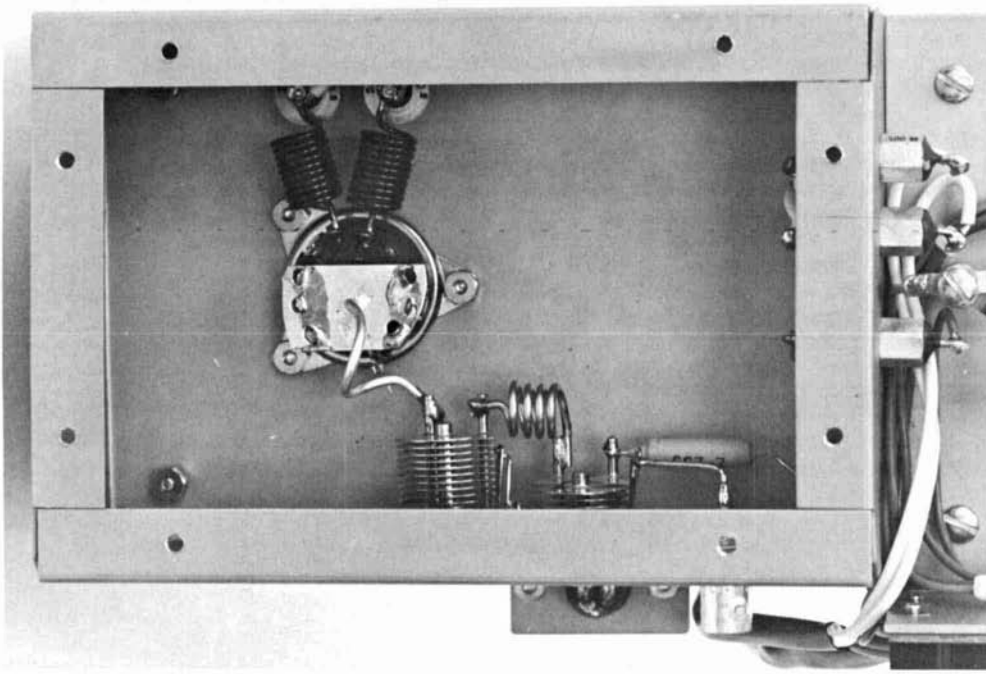
FT are 500-pF feedthrough capacitors (Erie type 327)

fig. 2. Exploded view of the 220-MHz power amplifier.

the capacitor. The two variable capacitors allow the network to cover a wide range of impedance transformations.

The variable capacitor C1 is mounted on the bottom side of the input circuit chassis. The shunt capacitor, C2, is also mounted on this side of the chassis to allow easy adjustment from the bottom of the amplifier. Front panel access to these two controls did not seem desirable since these adjustments don't require attention very often.

The layout of input circuit components is seen in the photographs. The



Cathode input circuit. Cathode terminals are interconnected with small copper plate. Filament chokes L3 and L4 are at top. Cathode input matching circuit is at the lower right inside the box.

input network is in the chassis box at the left. Capacitor C1 is the smaller capacitor adjacent to the rf input coax fitting. L1 is the coil running between the adjacent variable capacitors, C1 and C2. The one-turn inductance between the center of the tube socket and the variable capacitor C2 is L2. This coil is terminated in the center of the copper plate connecting all cathode leads together to keep the path length to all cathode leads the same.

The photograph of the socket assembly shows the control-grid collet assembly which is used to ground the control grid

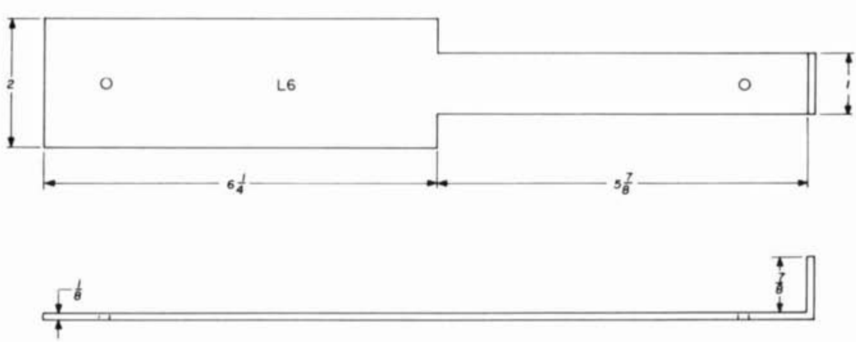
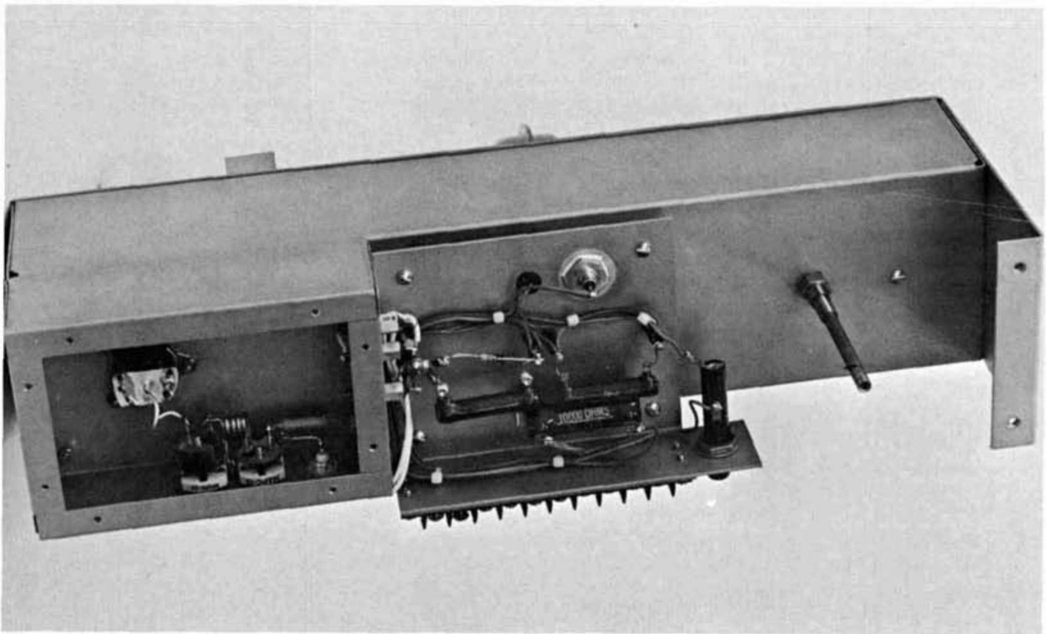


fig. 3. Plate line for the 220 MHz amplifier.

and to mount the socket. The control-grid contact is an Eimac 008292 collet soldered to a 1/16-inch thick copper ring, two inches in diameter with a hole 1-7/16 inches in diameter in the center. The three mounting screws are 4/40 captive stainless studs, 1/4-inch long, and are positioned to line up with the holes in the Johnson socket (Johnson 124-311-100).

Standby plate current of the 8874 is reduced to a very low value by use of a 10k, 25-watt cathode resistor which is shorted out when the amplifier vox circuit is energized, permitting the tube to operate in normal fashion. A 200-ohm safety resistor insures that the negative power circuit of the amplifier does not rise above ground potential if the positive terminal of the plate supply is accidentally grounded. A second safety resistor is placed across the zener diode to provide a load for the zener; it also prevents the cathode potential from rising if the zener should accidentally burn open.

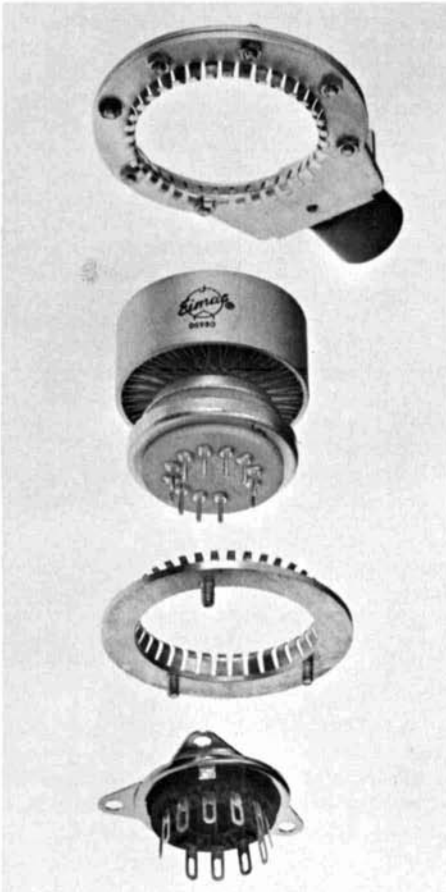


Amplifier with front panel removed. Cathode input circuit is in box at left with tuning capacitors C1 and C2 mounted on bottom. The 8874 tube socket, with cathode terminals interconnected by a small copper plate, is mounted to the rear of the box. At center are the resistors, zener diode, 1N2071 diodes and the zener protection fuse. The shaft at the right is the plate circuit tuning control.

The amplifier grid (**fig. 1**) is operated at dc ground; the grid ring at the base of the 8874 provides a low-inductance path between the grid element and the chassis. Plate and grid currents are measured in the cathode return lead with a 12-volt, 50-watt zener diode in series with the negative return to set the desired value of idling current. Two additional diodes are shunted across the meter circuit to protect the movements against destructive overload.

plate circuit

The plate circuit of the amplifier is a half-wave open transmission line. A quarter-wave line could have been used with a small improvement in bandwidth



Exploded view of the tube socket, grid collet, tube and anode connector. The anode assembly is made of two copper rings which encircle the tube; the rings are clamped together with the collet in between. Bottom ring has a flange which is attached to plate blocking capacitor C5.

and efficiency. However, the size of the plate circuit would be very small and more difficult to work with. A quarter-wave line would terminate approximately at the first mounting screw for the plate-line mount.

The half-wave line was made wide at the open end to allow sufficient area so that enough capacitance could be obtained in the tuning and loading capacitors without reducing the plate-to-plate spacing which would degrade the voltage hold-off capability. A low-impedance half-wave line was too long to fit into the 17 inch chassis. Therefore, a shorter line was narrowed at the high current point to increase the inductance and make the line electrically longer.

The plate line is resonated by C6 while the loading is adjusted by C7. These two adjustments will interact to a certain extent and therefore the proper operating point must be determined by adjusting both controls several times.

A type-N coaxial fitting is connected to the moveable disc of the coupling capacitor. The fitting is centered in a special tubular assembly which permits the whole connector to slide in and out of the chassis mounting fixture; this allows the variable disc of the coupling capacitor to move with respect to the fixed plate mounted on the tube anode clamp. When the final loading adjustment has been set the sliding fitting is clamped by a fixture similar to the slider on a variable wire-wound resistor.

The disc is mounted on a threaded shaft which moves in and out through the threaded bushing on the front panel. To avoid jumpy tuning a fine thread was used. An alternative would be to give added support to the shaft by mounting a threaded nut on a strap placed ½- to ¾-inch from the sub-panel. This would

Metal/ceramic construction now in Eimac zero-bias triodes

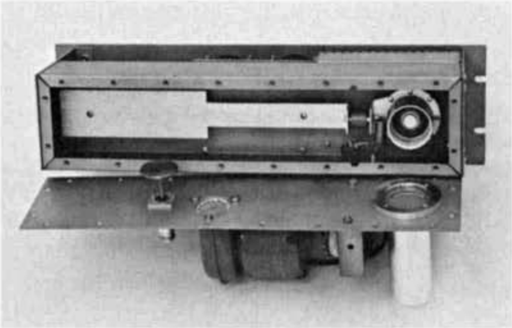
provide two supports for the threaded shaft.

The plate contact assembly is made from two copper rings and an Eimac 008294 collet clamped together with 4-40 brass machine screws. One of the rings in the clamp has a flange to provide a mounting bracket for the plate blocking capacitor, C5.

The Centralab capacitor (C3) mounted in parallel with the feedthrough, C4, was necessary to remove rf from the plate voltage lead outside the enclosure. The feedthrough capacitor did not do the job by itself.

layout and design

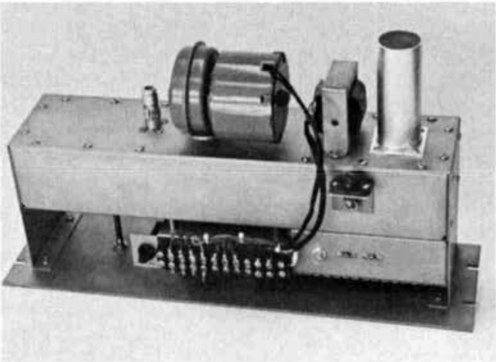
The amplifier is built with two standard aluminum chassis. The plate compartment is made from a 3 x 4 x 17-inch chassis; the grid enclosure is made from a 2 x 4 x 6-inch chassis assembly that is attached to a standard 5¼ x 19-inch relay-rack panel. The front panel also supports the grid and plate current meters. Just behind the panel and next to the grid compartment (which is mounted at one end of the longer chassis) is a flat



Anode circuit. Tube is at right, with plate line extending to the left. The disc at the left end of the cover plate is the load coupling capacitor C7. A Teflon chimney for the 8874 sits on top the tube anode and protrudes out of the waveguide-beyond-cutoff air pipe in the cover plate. Note the rf filter in the exhaust port of the blower.

aluminum plate that supports the three large resistors, the zener diode, terminal strip and the fuse in series with the zener.

The pictorial drawing in **fig. 2** shows how the whole chassis assembly is put together. The back panel of the plate compartment is used to make an rf shield,



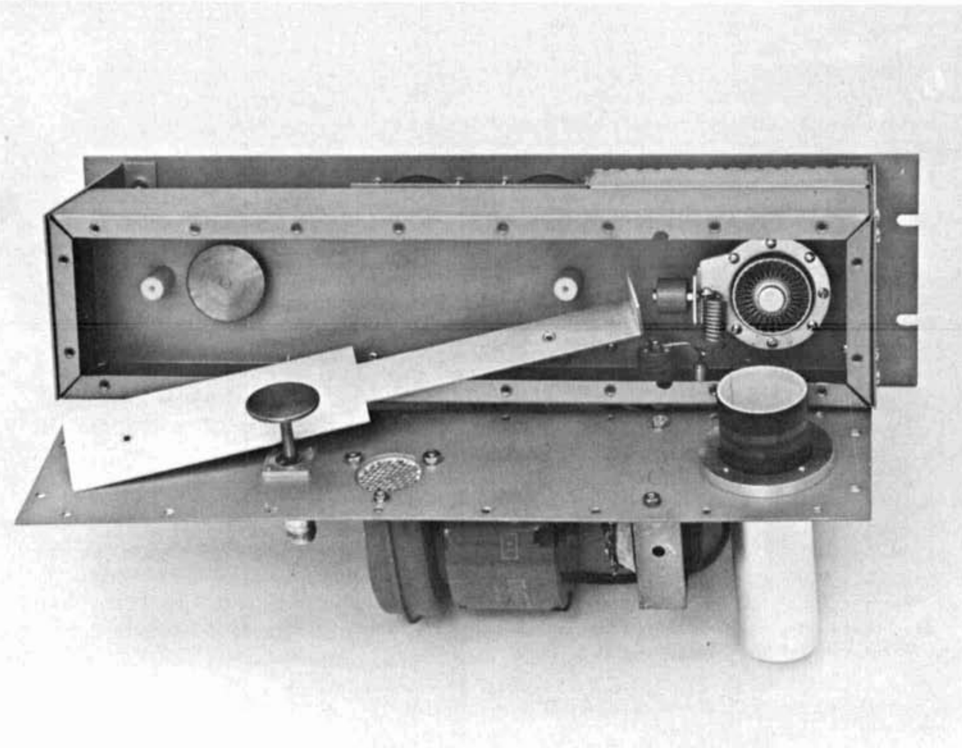
Rear view of 220-MHz amplifier. The two adjustments for the cathode circuit and input coaxial receptacle are at lower right. Type-N output connector is to left of the blower. Filament transformer and air duct are at the right-hand end.

an air-tight enclosure, and to serve as the mounting deck for the blower, the filament transformer, the rf output connector and the exhaust port for the cooling system. The centrifugal blower forces cooling air into the plate compartment and the air escapes through the anode cooling fins of the 8874, the Teflon air chimney and finally, out through a waveguide-beyond-cutoff air pipe.

The cooling-air inlet hole is also shielded from rf using the waveguide-beyond-cutoff technique. In this case a piece of copper honeycomb similar to a radiator core was soldered into the center of a ring and the assembly mounted between the blower outlet and the back plate of the chassis.

operation

Amplifier operation is completely stable with no parasitics. The unit tunes smoothly and the plate current dip occurs at the same time as the power output peaks. As with all grounded-grid amplifiers, excitation should never be applied



Anode compartment with plate line removed. Line has been displaced from its two Teflon support pillars to show the moveable disc of the plate tuning capacitor C6.

when plate voltage is removed from the amplifier.

The first step is to grid-dip the input and output circuits to near resonance with the 8874 in the socket. An swr meter should be placed in series with the input line and the input network adjusted for lowest vswr on the line from the exciter.

Tuning and loading follows the same sequence as any grounded-grid amplifier. Connect a swr indicator and load to the output of the amplifier and apply a small amount of rf drive. Quickly tune the plate circuit to resonance.

The cathode circuit should now be resonated. The vswr measured between the exciter and the amplifier will not necessarily be optimum. Final adjustment on the cathode circuit for minimum vswr should be done at full power level because the input impedance of a cathode-driven amplifier is a function of the plate current of the tube.

Increase the rf drive in small increments along with the output coupling until the desired power level is reached. By simultaneously adjusting the drive and loading it will be possible to attain the operating conditions given in the performance chart in **table 1.** Always tune for maximum plate efficiency, that is, maximum output power for minimum input power. It is quite easy to load heavily and underdrive to get the desired power input, but power output will be down if this is done.

My thanks to Dick Rasor, WA6NXB, for his help in adjusting and determining the operating conditions for this amplifier.

ham radio

evaluating semiconductor diodes

Here are three simple tests for determining important diode characteristics: germanium or silicon, peak-inverse voltage and maximum current

Carl C. Drumeller, W5JJ, 5824 N. W. 59th Street, Warr Acres, Oklahoma 73122

Semiconductor diodes are widely used by radio amateurs. Fortunately, surplus diodes are both plentiful and inexpensive. However, not all are marked, and even some that are marked carry *house* identifications that are difficult if not impossible to check for characteristics. This article describes some checks that are easily made with equipment available in the average experimenter's workshop to determine many of the characteristics you need to know to put the diodes into service.

silicon or germanium?

First you'd like to know whether the unidentified diode is made of germanium or silicon. Since selenium and copper-oxide diodes are not often found they will not be discussed here. Here's a quick and easy test. Note the circuit in **fig. 1**; it calls for a source of variable direct-current voltage, a couple of meters and a resistor. You'll need only a few volts from the supply, the meters can be multimeters of an inexpensive variety, and the resistor is quite noncritical, as it serves as a current limiter and must handle only a few milliamperes. The voltage meter should have a scale that lets you easily tell the difference between 0.4 and 0.7 volt. The other meter should be a low-range milliammeter, preferably one with rather high internal resistance. Note that the diode is connected for forward conductance.

To determine the nature of the diode, slowly advance the voltage from the variable source until the milliammeter starts an abrupt spurt of current. Stop right there and read the voltage. If it's in the general range of 0.4 volt, you have a germanium diode. If it took around 0.7 volt, it's a silicon diode.

peak-inverse voltage

Now that you know what type diode you have, your next thought may relate to just what peak-inverse voltage you can impose on the diode and still keep it viable. For this check, you'll need another variable-voltage power source with a much higher upper potential, one that exceeds any expected PIV. The test setup is shown in **fig. 2.** Note that this time you put the diode in backwards; that is, you connect it in the normally nonconducting direction.

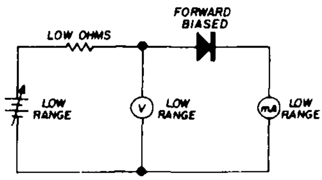


fig. 1. To determine whether the diode is silicon or germanium, put the unknown diode in this circuit, adjust the power supply until the *milliameter starts to show current, and read* the voltmeter. Voltage in the vicinity of 0.4 volts indicates a germanium device; 0.7 volts, a silicon diode.

The resistor needs to be large enough to limit the current to a few milliamperes; if you're expecting to use over one-thousand volts it's best to use several resistors in series to discourage voltage breakdown. The test procedure is the same as before: increase the voltage slowly until the milliammeter starts showing current. Stop there, note the voltage, and back off before you destroy the diode.

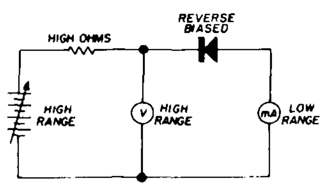


fig. 2. Diode PIV test circuit. Adjust the power supply until the milliameter shows current and read the PIV on the highrange voltmeter.

maximum current

Maximum current-carrying capability is not so easily determined. You can get an approximation, however, with the circuit shown in **fig. 3.** Here again the resistor is for current limiting and must carry the maximum expected current capability of the diode. The variable-voltage source will not need to provide much voltage, but it must be capable of supplying the maximum current you suspect the diode may sustain. The ammeter, of course, also must have a range encompassing the highest current expected.

The check will not give you precise results, as you must make one qualitative evaluation: the heat of the diode. That's how you make the test; you increase the current flow until the diode gets hot. Just how hot is a matter you must decide. If it's a small diode, cooled only by the leads and convection air flow, you'd better stop when it starts to get warm. If, though, it's a husky brute, meant to be

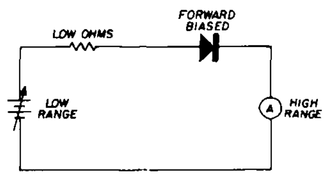


fig. 3. Maximum current-carrying capability of the diode is roughly determined by the amount of heat dissipated by the device in this circuit (see text).

mounted on a big heat sink, you can run it to the finger-burning stage! Just don't get carried away with trying to push the current to the utmost limit, or you may end up with a cooked diode.

Also, on PIV or maximum-current tests, don't check just one diode and assume that all of that type or number will show the same characteristics; the probabilities are that they will not. In PIV, especially, they'll vary over a wide range. And not all germanium or silicon diodes will exhibit a uniform forward-conduction threshold voltage.

These three simple tests, easily made with commonly-available equipment, will give you most of the information you need to put those stray diodes into use in your ham shack.

ham radio

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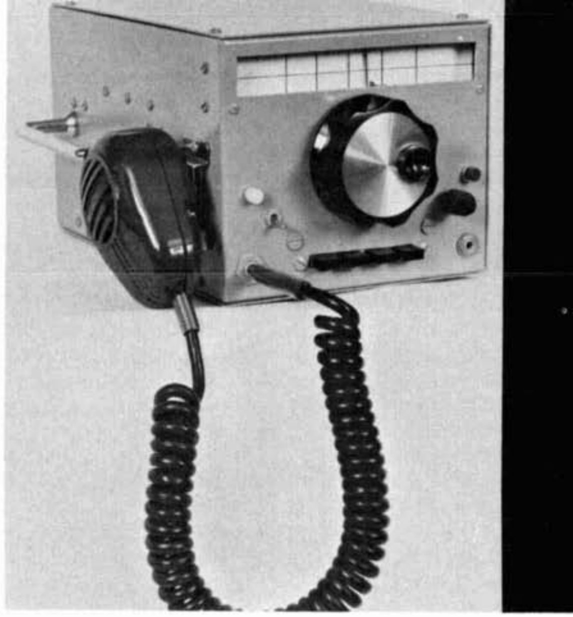


amplitude-modulated two-meter transmitter-receiver

This compact transceiver for two meters features a high-performance mosfet receiving converter, IC i-f and audio and 10-watt rf output

Robert A. Thompson, K1AOB, 60 Buck Thorne Avenue, Riverside, Rhode Island

Riding on the coat tails of the current wave of two-meter fm activity is an increase in two-meter operation in general. SCR-522s and ARC-4s are being dusted off and fired up again; mountain-topping and mobiling have attracted renewed enthusiasm.

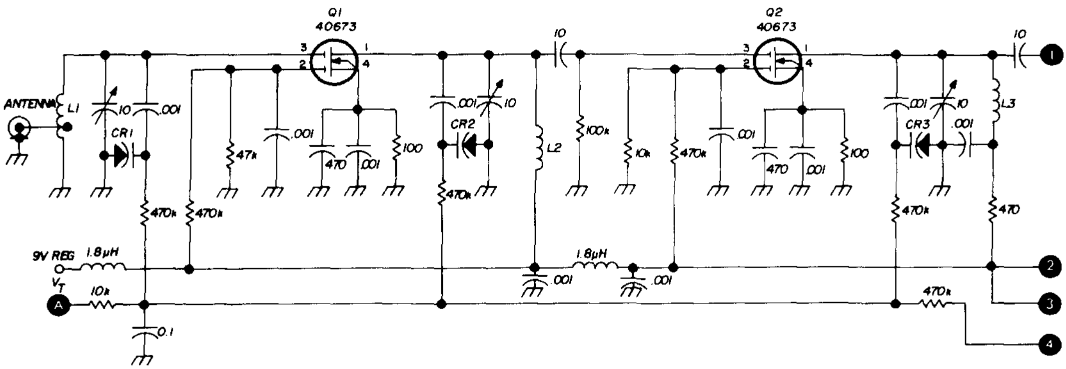
The two-meter a-m transmitter-receiver described here is an attempt to provide a unit suitable for mountain topping and mobiling. The rig serves its purpose admirably and has provided much enjoyment. However, you must remember that this is a minimum-specification rig; it does not contain any luxury features which might be desired by others.

Since advanced vhf constructors seldom duplicate equipment completely this article is presented more as a source of ideas than as a one-for-one construction article. For this reason the unit schematics are shown individually.

performance

With an input of 12.6 volts dc the transmitter will provide 10 watts into a 50-ohm load with average modulation. Slightly greater power output is available with the engine running as the alternator usually increases the voltage to about 13.5 volts. The modulator is capable of producing more than ample audio and must be initially adjusted with the internal input potentiometer to prevent splatter.

The receiver has some unique aspects. For example, the dial has no frequency markings but is divided into four blocks. There are four push-buttons under the



L1	3 turns no. 22, airwound, 1/4" diameter, 3/4" long, tapped 1 turn from ground end
L2,L3	3 turns no. 22, airwound, 1/4" diameter, 3/4" long
L4	3 turns no 16, airwound, 1/4" diameter, 3/4" long
T1,T2,T3	see text

tuning knob. When then the first button is depressed, the receiver tunes from 144 to 145 MHz. Therefore, each block on the dial represents 250 kHz.

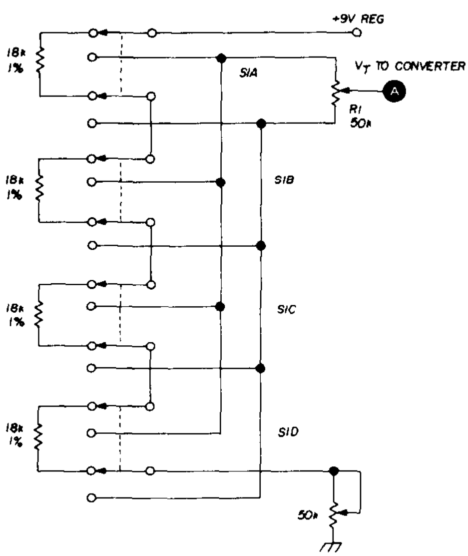


fig. 2. The MHz selector switch; S1 is a 4-station push-button switch with interlock.

These dial segments can be further subdivided for additional accuracy if desired. The push-buttons interlock so that when the second button is depressed the first disengages and the dial now represents frequencies from 145 to 146 MHz.

Since the dial is four inches long this arrangement is equivalent to a dial sixteen inches long! It takes about three and one half turns of the tuning knob to traverse the dial; this is 14 turns for the entire two-meter band.

converter

To tune the converter a variable voltage is used to reverse bias diodes CR1, CR2, CR3 and CR4. (See **fig. 1.**) When any solid state diode is reverse biased its junction exhibits a capacitance effect; the BA-110 diodes are specifically designed for use in tuned circuits.

They are effectively across the tuned circuits of the rf amplifier and local oscillator. This method of tuning frees the builder from the bulky tuning capacitor and the necessity of mechanically coupling it to the tuning knob and dial. With this method you could even mount the converter on the antenna and tune it remotely!

Two stages of rf amplification provide input sensitivity on the order of 0.1 microvolt. RCA 40673 mosfets are used in the rf amplifiers and mixer. These transistors include internal protection against breakdown from static electricity.

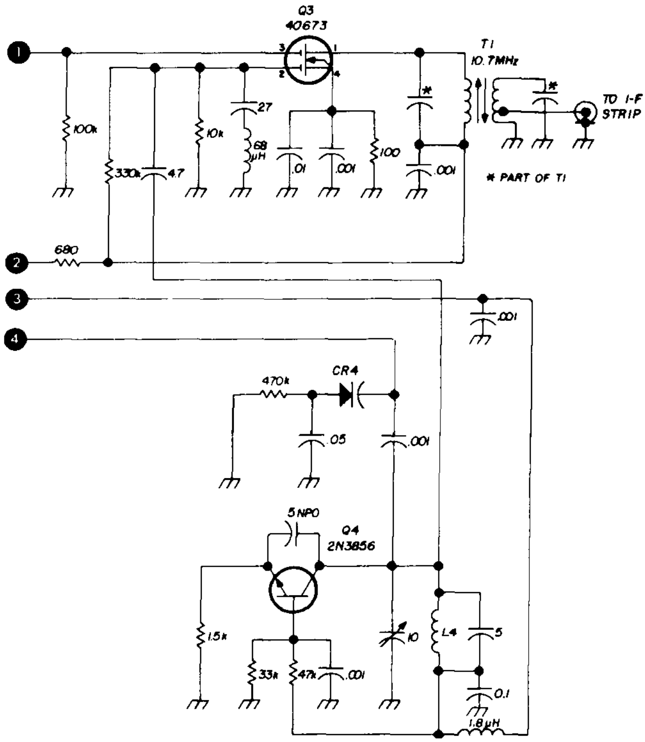


fig. 1. Two-meter receiving converter. All variable capacitors marked 10 pF are 1.5 to 10 pF compression trimmers. Diodes CR1 through CR4 are ITT type BA110 tuning diodes.

Later addition of an fm detector was considered so provision was made to use its output voltage to feed an afc correction circuit. If fm will not be used all circuitry to the left of CR4 may be eliminated.

Double-tuned i-f transformers are preferable to single-tuned units at the mixer output (T1 in **fig. 1**). J. W. Miller manufactures several types which are satisfactory.

Oscillator coil L4 should be mounted as ruggedly as possible and secured with plastic cement to prevent any vibration. All coils are mounted at right angles to each other so shielding was unnecessary.

i-f strip

Single-tuned transformers are used in the i-f strip (**fig. 2**) because bandwidth is determined by the crystal filter that preceeds them. The transformers are used merely for interstage coupling. The i-f strip has adequate gain and about 50-dB of agc. Transistor Q5 provides some post-filter amplification while Q6 supplies agc and doubles as a detector.

receiver audio

The detector output is fed to an fet which drives a General Electric PA237 IC power amplifier (**fig. 3**). A problem with oscillation in the audio circuit was solved by the 8-ohm resistor across the speaker; this is made up of two 16-ohm, ½-watt resistors in parallel.

Maximum available audio is reduced slightly, but oscillations are eliminated, and the IC is protected if the speaker is disconnected with power applied.

The speaker was originally mounted internally. However, speaker vibration produced frequency modulation of the converter local oscillator so the speaker connection was brought out to a jack on the front panel.

voltage regulator

Since a voltage varied by a potentiometer is used to tune the receiver, that

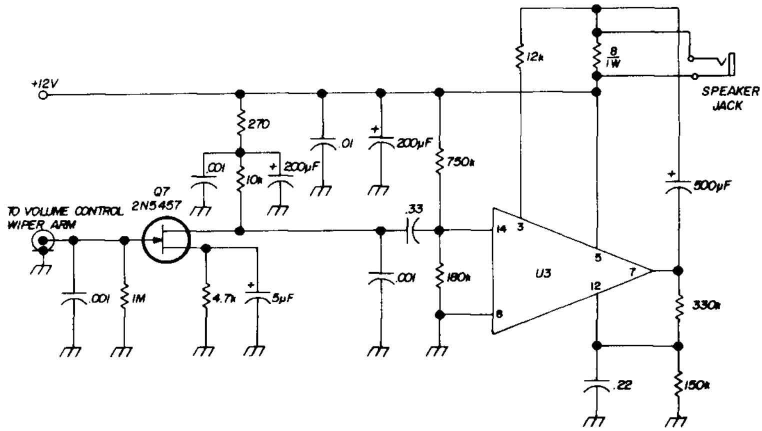


fig. 4. Receiver audio amplifier. Q7 is a 2N5457 or MPF103; U3 is a General-Electric PA237 IC audio power amplifier.

voltage must be very stable. Considering the voltage variation across the average automobile battery under normal driving conditions, this is no easy feat.

The voltage regulator in **fig. 5** maintains a constant output plus or minus a few millivolts with an input voltage swing from eleven to twenty volts. The resulting

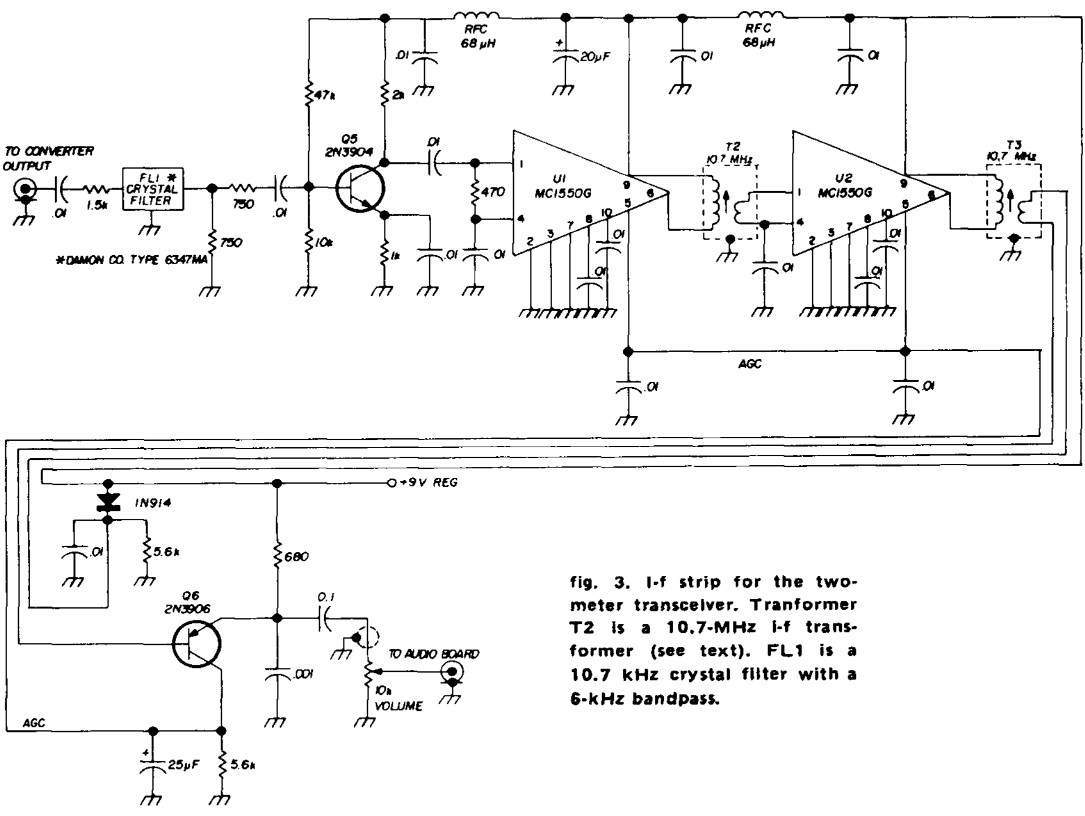


fig. 3. I-f strip for the two-meter transceiver. Tranformer T2 is a 10.7-MHz i-f transformer (see text). FL1 is a 10.7 kHz crystal filter with a 6-kHz bandpass.

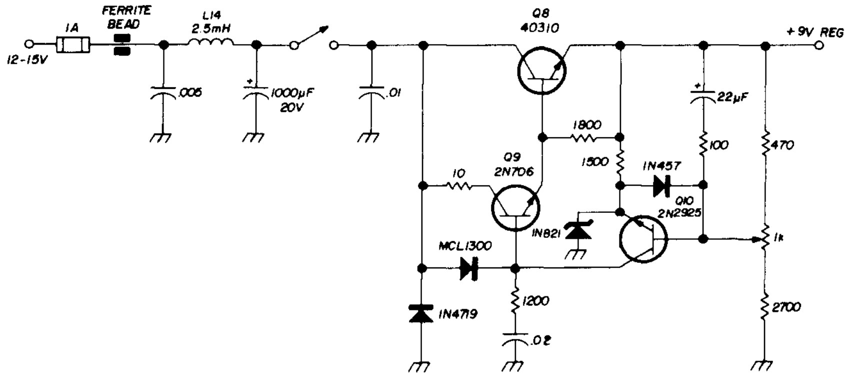


fig. 5. Regulated power supply provides constant 9-volt output with varying 12- to 15-volt input. Choke L14 is a Stancor TC-1.

regulated 9 volts is used only for the i-f strip and the converter. Everything else is fed from the 12-volt input to the unit.

The regulator is capable of much more current than is required in this application, and the circuit might be somewhat simplified. Perhaps one of the new IC regulators might suffice.

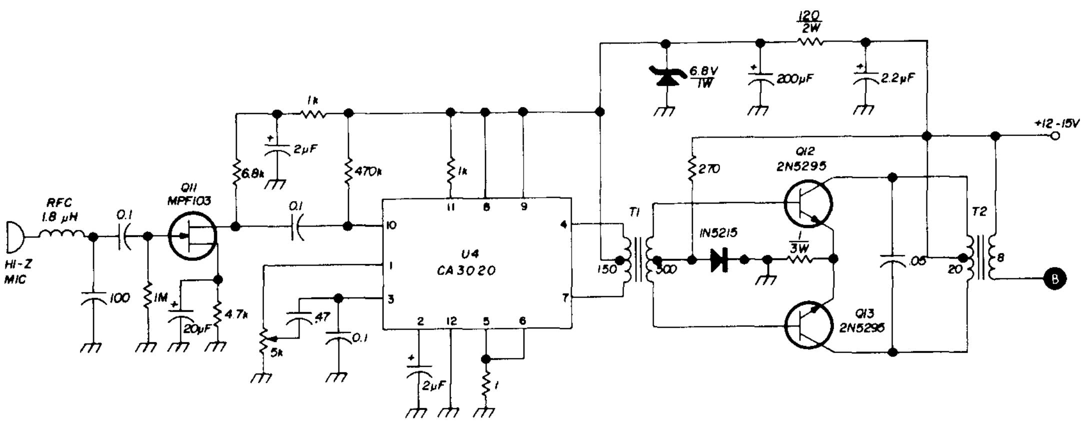


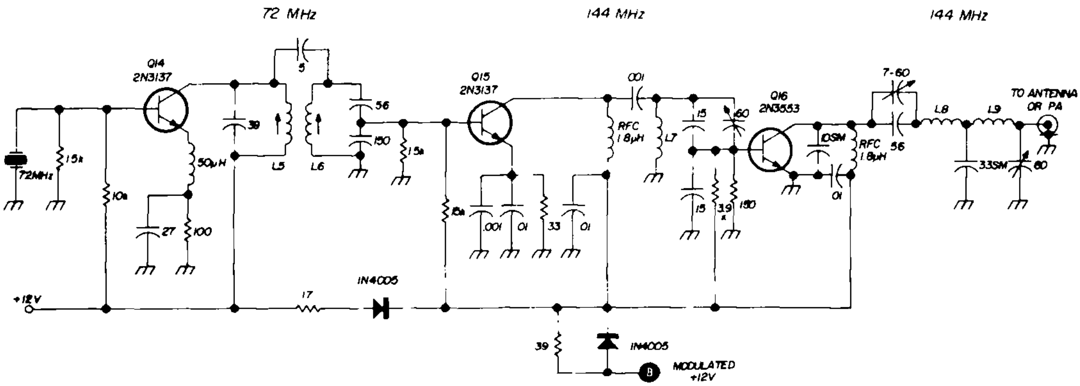
fig. 6. Amplitude modulator for the two-meter transceiver. Transformer T1, 150:500 ohms, is an Argonne AR163 (Lafayette); transformer T2, 20:8 ohms, is a Stancor TA-12.

transmitter

In the modulator a high-impedance microphone feeds an fet which drives a CA3020 integrated circuit, followed by transistors Q12 and Q13. The 5k modulation-level control is mounted on the board; it is adjusted only once during initial tuneup. Heat sinks must be provided for Q12 and Q13.

The oscillator-driver strip is capable of producing three watts into 50 ohms and can be used without the amplifier. An overtone crystal oscillator (Q14) supplies 72-MHz drive to Q15 via bandpass coupling consisting of L5 and L6. Transistor Q15 doubles to 144 MHz and drives Q16 straight through on two meters. The 2N3137 works particularly well in this circuit. Other rf transistors tried for Q14 and Q15 resulted in lower output power.

The final power amplifier, Q17, uses a transistor rated for lower frequencies. Higher frequency types were tried initially, but oscillations were difficult to control, and tolerance for load mismatch was nil. The 2N2876 exhibited none of these problems.



L5,L6 — 3 turns no. 22 on ¼" form, ½" long

L7,L9 — 4 turns no. 22, airwound, 5/16" ID, ½" long

L8 — 6 turns no. 22, airwound, 5/16" ID, ½" long

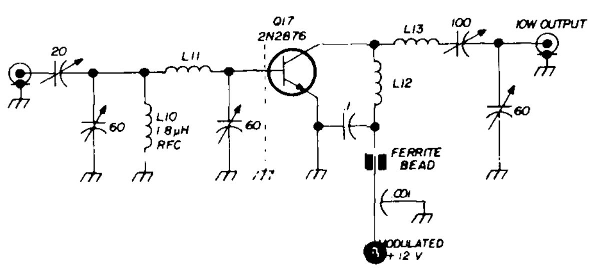
fig. 7. Oscillator-driver for the two-meter transmitter.

mhz selector

Each push-button in the MHz selector switch is a dpdt unit. The divider resistors are all 18,000 ohms, 1%. However, the 5% resistors manufactured by Allen Bradley may be used as these are usually within 2%.

The value of the divider resistors is determined by the number of turns of the 10-turn pot that are required to traverse the dial once, the voltage-capacitance curves of the tuning diodes and the amount of frequency coverage per switch.

For different dial lengths and/or tuning diodes I would recommend an experimental approach rather than a mathematical one due to the number of variables involved. The 50k pot sets the lower voltage limit of the divider network



L10 — 1.8 μH RFC

L11 — 7 turns no. 24, airwound, ¼" ID

L12,L13 — 4 turns no. 24, airwound, ¼" ID

fig. 8. Ten-watt power amplifier for the two-meter transceiver.

and hence, the low-voltage end of the tuning range.

Depression of a push-button puts the 10-turn pot in series with three of the 18k resistors that make up the voltage divider. If desired the entire band can be tuned in one sweep of the dial by eliminating the push-button switch and divider resistors. This will, however, reduce bandspread by a factor of four.

construction

The rig is built in a 5 x 6 x 9-inch aluminum utility box. An aluminum panel is placed across the inside of the box about 2 inches down from the top. The transmitter and modulator printed-circuit boards are mounted on this panel with 3/8-inch threaded standoffs.

The front end, i-f strip, audio amplifier and voltage regulator are mounted around the sides and the rear wall of the enclosure. This arrangement lends itself to adjustments and ease of construction. A Jones plug for power, a fuse holder and a BNC antenna jack are mounted on the

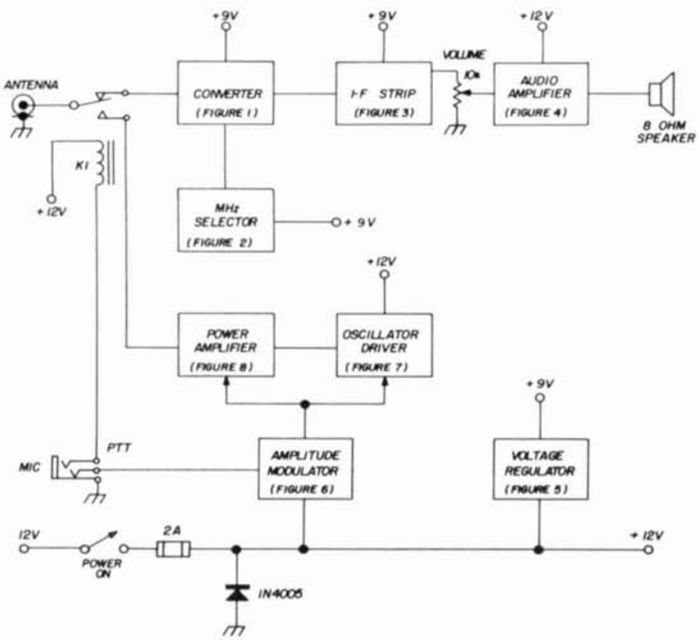
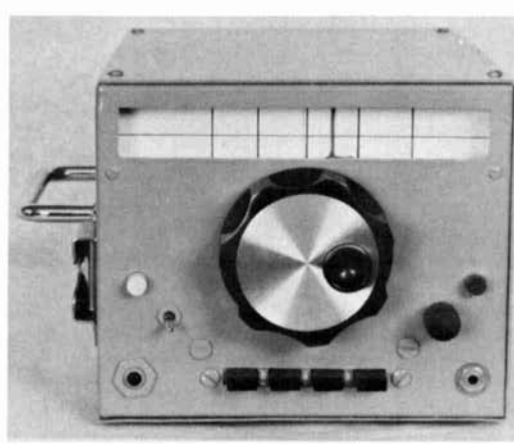


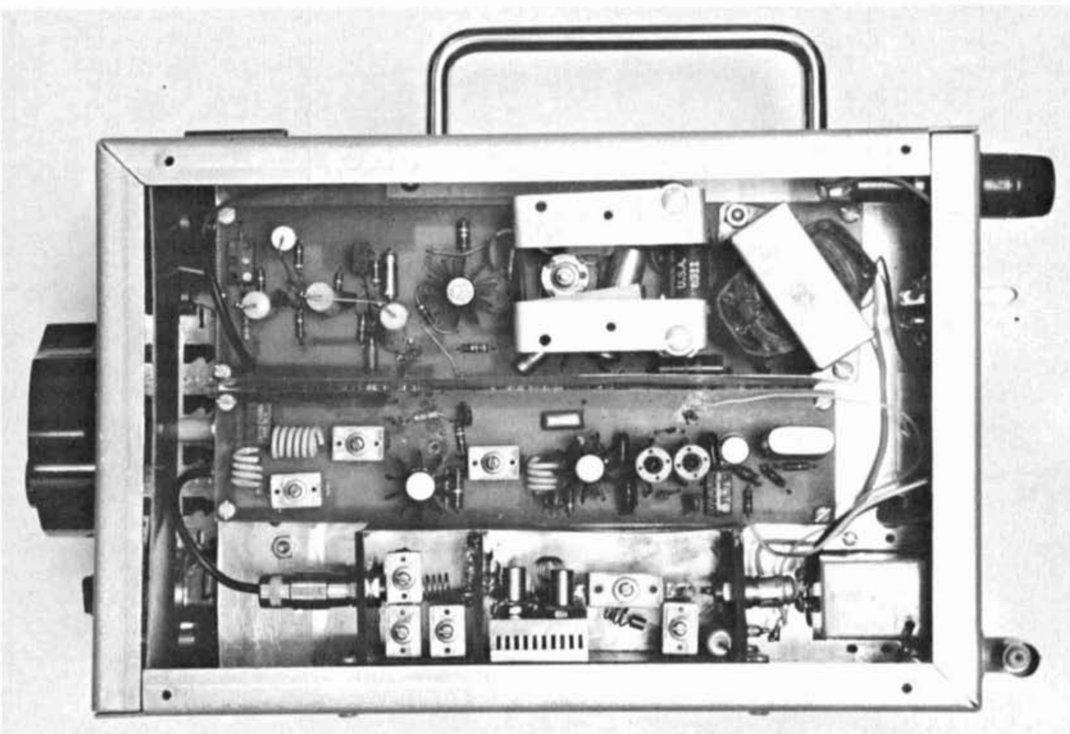
fig. 9. Interconnection of each of the modules used in the two-meter transceiver. K1 is a 12-volt coaxial relay. K2 removes power from the converter and i-f strip during transmit.



Front panel of the two-meter transceiver.

rear panel. On the front panel are the tuning knob, a power switch, the volume control, the push-button MHz selector switch, indicator lights and jacks for the speaker and microphone.

rf and mixer transistors, and a plastic socket was used for the oscillator. Nylon or plastic sockets may be acceptable for the rf and mixer stages, but the light brown Bakelite socket should be avoided



The modular construction style is shown in this detail photo of the rig with the bottom cover removed. Note the power amplifier wiring at the bottom.

at these frequencies.

Printed-circuit boards were used for the modulator and oscillator-driver. The power amplifier is wired on double clad 1/8-inch thick board but is made with conventional chassis-type construction. There is a shield partition between the input circuitry and the base of the power transistor. The 2N2876 is mounted on a 1 x 1 x ½-inch block of aluminum which serves as a heat sink.

The tunable converter was also built on a piece of double-sided printed-circuit board. Holes were drilled and transistor sockets mounted in the conventional manner; Teflon sockets were used for the

Terminals are silver pins pushed through Teflon inserts. These were used mainly to conserve space; any other type may be used.

The i-f cans were laid on their sides and soldered to the board. IC sockets were also laid on their sides and epoxied to the board. This method of construction was previously described.[5] The audio amplifier is built in the same manner. The voltage regulator is mounted on a conventional printed-circuit board.

The shaft that connects the tuning knob to the 10-turn pot should be nonmetallic. A microphone clip is provided on one side of the box, and behind it is a handle. The side mounting does not interfere with under-the-dash mounting arrangements and still provides utility.

The slide-rule dial incorporates a length of dial cord looped over the tuning shaft twice and around two small pulleys at the bottom corners of the dial opening. The dial cord is tied to opposite ends of a small spring which provides the necessary tension. A small piece of plastic-covered solid copper wire is looped around the spring and held with Pliobond adhesive while the other end is looped over the top of the dial face. This provides a pointer.

alignment

Alignment procedures for vhf equipment are fairly standard and should be familiar enough not to warrant a detailed discussion here. However, there are a few points that it might be well to underscore.

I-f: Apply a modulated 10.7-MHz signal to the input to the i-f amplifier through a 10-pF capacitor and adjust the i-f transformers for proper waveshape at the input to the detector transistor. (Use a scope capable of displaying 10.7 MHz.) If a scope is not available adjust the i-f for maximum audio at the speaker. Keep reducing the input signal to the minimum discernable level when peaking. Connect the converter output to the i-f amplifier input.

Converter: Apply an accurate, modulated 144-MHz signal source to the antenna jack. Set the compression trimmers about midway through their range. Set the dial at the point where you want 144 MHz to be and adjust the 50k pot on the bottom of the voltage divider string to about 4.5 volts. Squeeze or spread the turns on L4 until the 144-MHz signal is heard. (It may be necessary to adjust the 50k pot again slightly.) Peak transformer T1; peak L1, L2 and L3 in the same manner as L4.

Move the dial to where 148 MHz will be. Set the signal generator to 148 MHz and adjust the trimmer across L4 so that the 148 MHz signal can be heard. The tuning voltage should be close to 9 volts. Adjust the trimmers across L1, L2 and L3. Since these adjustments interact you will have to go back and readjust the 144-MHz setting.

Repetition of the above steps will gradually reduce the amount of adjustment necessary each time until the set is aligned. Remember that the inductance sets the lower end and the trimmer capacitors set the high end of the tuning range. As with the i-f strip, keep the input from the signal generator as low as possible to prevent overdriving.

Transmitter: The important thing to keep in mind when aligning any solid-state transmitter is to apply reduced power initially. In this case use about 9 volts. Connect a wattmeter to the output of the amplifier and, starting with the oscillator, peak each stage for maximum. It might be necessary to back L5's slug off slightly from its peak setting to insure oscillator starting every time power is applied.

Throughout tuneup procedure momentarily remove the crystal to insure that there is no self-oscillation. Gradually increase the power supply to full voltage. With a dummy load on the antenna, a nearby receiver can be used to set the 5k modulation control. With normal voice modulation increase the pot until splatter is noted on the receiver, then backoff slightly. An actual on-the-air check will provide the basis for further adjustments.

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ham radio

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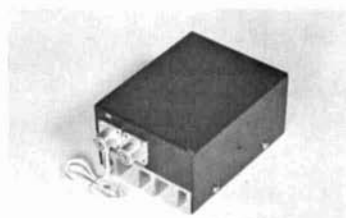

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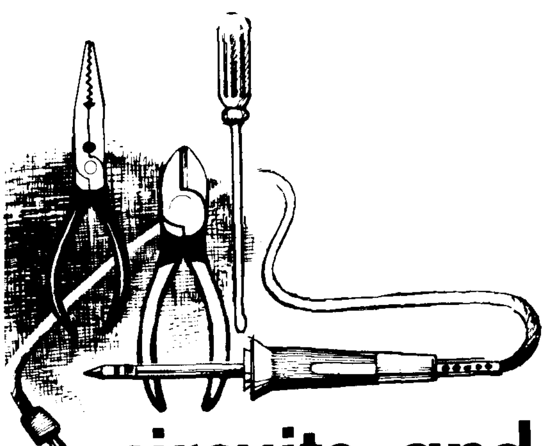


circuits and techniques

ed noll, W3FQJ

vhf beacons

The RSGB and various European groups and clubs are to be congratulated on their vhf beacon facilities. Even little Iceland has a beacon station. In the study of vhf propagation and early forecasting of openings they are marvelous, and they permit a high order of systematic and recorded scientific investigation of sporadic-E, abnormal tropospheric, aurora and other propagation modes. It might well be that they are putting the English and European hams well in the forefront in these endeavors.

The value of the vhf beacons is not confined to propagation studies alone. These signals are transmitted continuously and are always available for amateur tests and measurements. They are a great benefit in checking antennas and receiver front ends and as frequency check points. Also, it would not be an unsurmountable problem to adapt them for use as satellite test-signal sources when the era of long-distance vhf communications begins for the radio amateur.

There is abundant unused spectrum in our vhf/uhf bands. The Technician license was initiated in hopes of some concerted vhf-uhf experimentation. A system of beacons could be a splendid scientific tool.

The caliber of the RSGB effort is disclosed in an article by R. A. Ham in the June 21, 1971 issue of the *British Electronics Weekly.*[1] For example, in the study of tropospheric changes, a barograph chart of beacon signal level vs barometric pressure is kept. Mr. Ham's tests indicate that when the pressure rises to the 30-inch level, and then begins an additional steady rise, a likely opening can be anticipated at the time the pressure begins to fall. In fact, there is some rise in the magnitude of local signal in the latter period of the rise and then long-distance openings are set off with the moment of decline.

In other checks, Mr. Ham was able to monitor European, English and Icelandic beacons continuously under sporadic-E conditions. He was able to come up with various patterns of range and direction changes that resulted from the E activity.

phase-locked operation on vhf

The vhf potentials of the phase-locked loop were mentioned in a previous

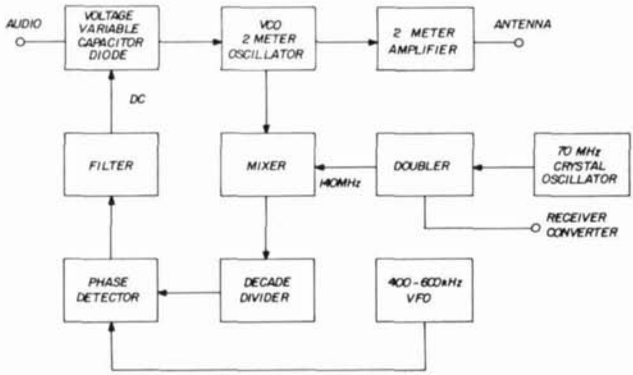


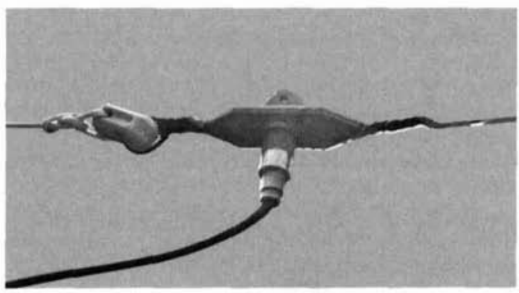
fig. 1. Two-meter phase-lock facility used by G3WXO.

column. G3WXO[2] uses a decade counter (Motorola SN7490N) and a quadruple two-input positive NAND gate (Motorola SN7400N) connected as a phase detector in the lock path (**fig. 1**). No multiplier chain is used; the fixed frequency is generated directly by a voltage-controlled two-meter oscillator. The oscillator output supplies signal to a follow-up two-meter amplifier.

A portion of the output is applied to a mixer along with a 140-MHz crystal-controlled component. The difference frequency (4-to 6-MHz range) is applied to the decade counter.

The phase-detector compares the output of the counter with the output of the low-frequency variable-frequency oscillator which is tunable from 400 to 600 kHz. This oscillator is the vfo control for the transmitter. The dc-control voltage at the output of the phase detector is applied to the voltage-controlled 2-meter oscillator by way of an appropriate filter.

A varactor-diode circuit responds to the dc-control voltage. It is possible to change the frequency of the voltage-controlled oscillator between 144 and 146 MHz by varying the frequency of the vfo. Furthermore, an audio signal can be used to frequency modulate the 2-meter oscillator directly. There is no trouble in obtaining full deviation with the center frequency held fast by the phase-lock system. In G3WXO's two-meter station the 140-MHz component is also used as local oscillator injection for his two-meter converter.

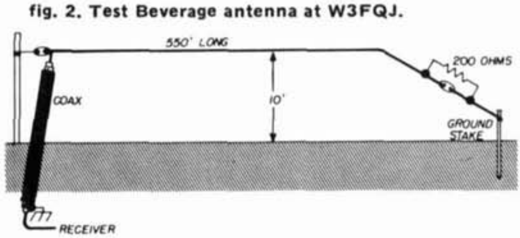


Feed end of the Beverage antenna.

beverage antenna

I covered the subject of anti-QRM receiving antennas in a previous column.[3] One of the antenna types mentioned was the Beverage. Its possibilities for receiving from a single general direction with mini-

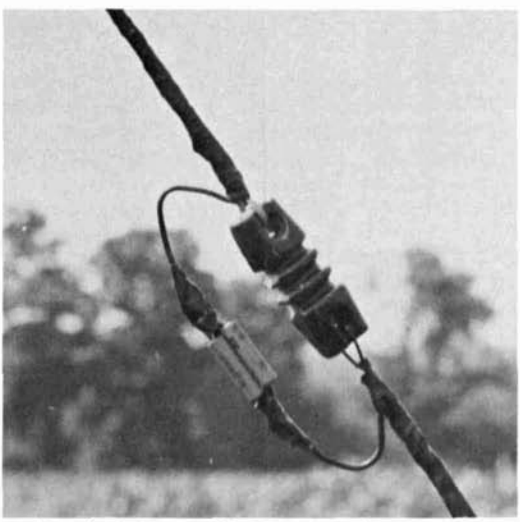
fig. 2. Test Beverage antenna at W3FQJ.



mum pickup from side and back were verified with a Beverage antenna at W3FQJ.

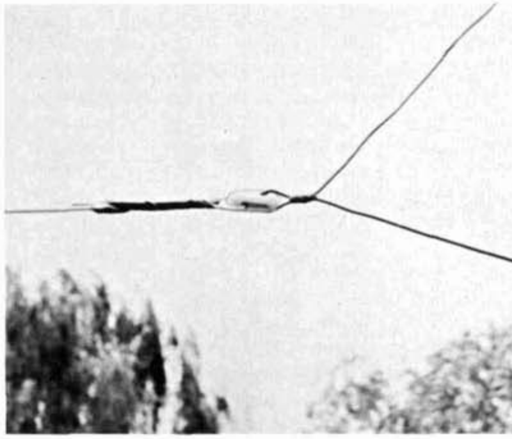
The antenna was short as Beverage types go; total length was 550 feet, **fig. 2**. Height at no point was more than 10-feet above ground. The end was terminated in a 200-ohm non-inductive resistance (three 600-ohm resistors in parallel). A ground stake was driven 4 feet into the ground. Approximately 120 feet of coaxial cable linked the feed end of the Beverage to the shack. The inner conductor of the coaxial cable was connected to the Beverage wire; no connection was made to the outer conductor at the antenna end. A coaxial switch permitted the receiver input to be switched rapidly between the Beverage antenna and the combination transmit-receive antennas used on the various amateur bands. Here are the results:

1. The Beverage antenna was highly directive off the far end. It favored low-angle long-distance signals over short-skip and local signals.



Terminated end of the Beverage antenna.

2. In general the received signal strength was lower than a good operating antenna on any specific band. However, back and especially side pickup was in most cases, less than similar pickup with the comparison antenna. That is, the ratio of the signal from desired direction over inter-



Construction used at the base angle of each element in the triangle beam.

ference from other directions was higher than with the comparison antenna.

3. Similar results were obtained on all bands 10 through 160 meters. The antenna was pointed about 15° south of west. Maximum direction therefore was directly across the continental United States and showed a definite preference for W5s, WØs and southern W6s.

Some directivity existed even on 160 meters despite the fact that the antenna should not be considered a true Beverage for this band since it is only about one wavelength long. Nevertheless, it provides a good cutback of W1 signal levels when tuning in signals from the corn-belt states. Vhf checks have yet to be made.

The Beverage antenna can also be loaded for transmitting. The best method of matching is to use the common T-network often used to match single-wire antennas to a transmitter. This network consists of two tapped coils and a single

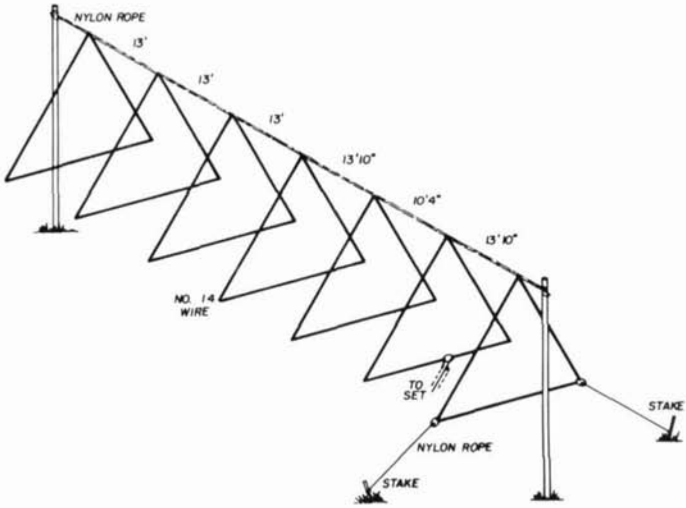
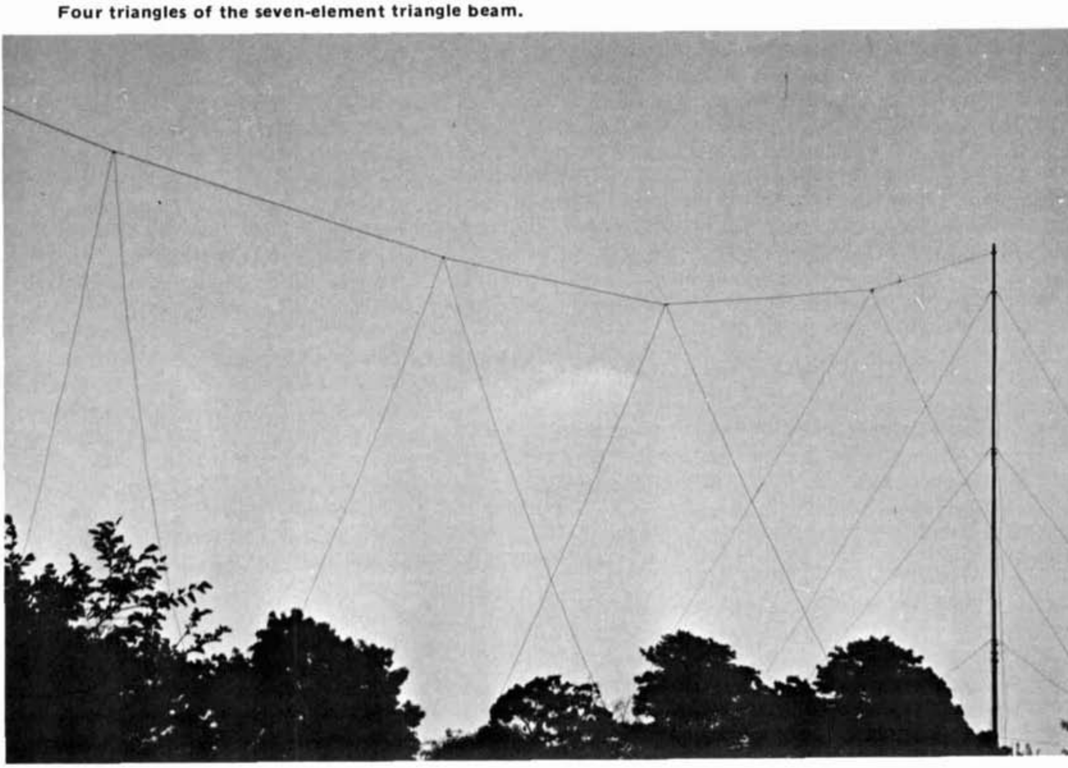


fig. 3. Seven-element 20-meter triangle beam. All elements are staked out the same as the reflector.

variable capacitor adjusted for a good match on each band. There was no trouble with loose rf in the shack with the use of coax between the transmitter and the fed end of the Beverage antenna.

Stations could be raised on each band in the favored direction despite the very low antenna. Reports would be a half S-unit to several S-units below comparison antennas. It was very difficult to raise

Four triangles of the seven-element triangle beam.



anyone off the favored angle. This latter condition checks out the reciprocity theorem, indicating very low sensitivity off the favored direction.

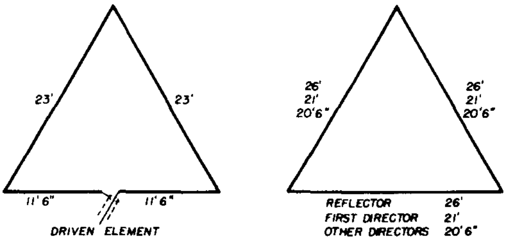


fig. 4. Dimensions of the elements used in the W3FQJ triangle 20-meter beam.

There is substantial work to be done on this style of antenna. The simple tests above just scratch the surface. Other amateurs who have done work with the Beverage indicate that the antenna should not be more than 10 feet above the ground or it will lose its low angle directivity and increase its side pickup.

There is a host of experiments to be done with various types of elaborate ground systems and the selection of length and height above ground to favor a specific band. Added height will increase signal pickup and transmit signal reports. However, just what is that optimum *height which will not permit a serious* cancellation of its anti-QRM characteristics when receiving?

another triangle

A high-gain beam antenna can be built at low cost with the full-wave triangle. A 20-meter seven-element triangle (driven, reflector and five directors) was constructed and suspended on nylon rope between two 40-foot telescoping TV masts, **fig. 3**. All of the closed full-wave configurations (quad, delta and triangle) perform well at low antenna heights. This is not to say that they cannot be improved upon by mounting them higher. Of the three types, however, the single-point top of the triangle is a definite advantage for low-cost storm-resistant mounting arrangements.

The seven elements were made of insulated wire. With the apex of the triangle at 40 feet off the ground the feed point of the driven triangle is readily accessible from ground level.

This antenna was positioned to favor Europe and performs well with 200 watts on a band crowded with high beam antennas and kilowatt transmitters. Raising the apex another 30 feet would permit some spectacular results with QRP power.

more phase-locked loop

Additional checks were made on the phase-locked loop circuit covered in September's "Circuits and Techniques."[4] A dc voltage-control circuit was added (**fig. 5**) to provide a means of changing the frequency of the voltage-controlled oscillator. Potentiometers replace the *variable capacitors of the previous circuit.* A fixed 250-pF capacitor between terminals 2 and 3 permitted tuning the

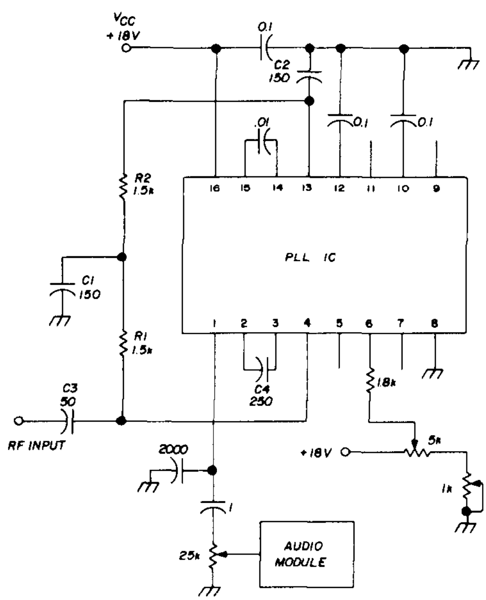


fig. 5. Phase-locked loop receiver with dc vco control.

160-meter band and the high-frequency end of the broadcast band.

Two potentiometers are connected in series as coarse and fine (bandspread) tuning controls. Excellent bandspreading can be obtained with this arrangement. For example, by using a bandspread potentiometer of several-hundred ohms, a 50-kHz segment of the 160-meter band can be spread over the entire dial. Hand-capacitance effect is virtually eliminated.

A simple fet amplifier improves the sensitivity of the receiver. Strong locals are a problem and sometimes must be trapped-out if you live in an area such as mine with a cluster of broadcast towers not too many miles away.

In one experiment, ***fig. 6****, the resonant* drain circuit was a replacement superhet rf transformer (such as Stancor 8736). The antenna winding was connected to the input of the phase-locked loop. The

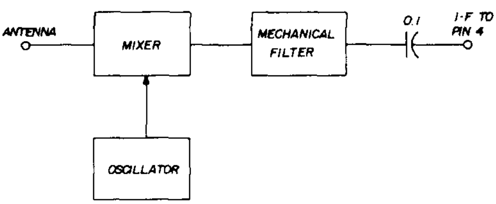


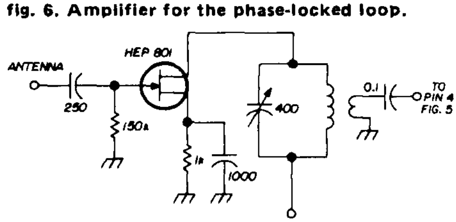
fig. 7. Use of a phase-locked loop in a superheterodyne receiver.

secondary was connected to the drain circuit of the fet. Proper adjustment of the transformer slug permitted operation on 160 meters and a large portion of the broadcast band as well.

Performance was excellent considering the simplicity of the receiver. Sensitivity was excellent with a suitable antenna; selectivity was quite good.

Selectivity is improved with the use of a mixer-oscillator ahead of the device using the phase-locked loop as an i-f amplifier and demodulator. In this arrangement a mechanical filter is placed between the mixer and the phase-locked loop, **fig. 7**.

fig. 6. Amplifier for the phase-locked loop.



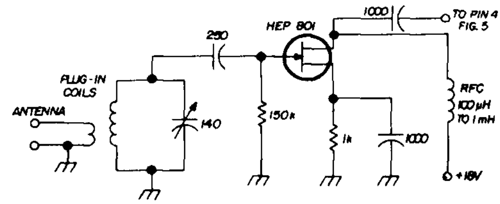


fig. 8. Multiband circuit arrangement for the phase-locked-loop receiver shown in fig. 5.

The arrangement of **fig. 8** was also checked out and gave good a-m performance on the 40-, 80- and 160-meter bands. A radio-frequency choke was connected in the drain circuit, while the resonant transformer was moved to the gate circuit. With this circuit arrangement a tapped resonant coil or plug-in coils can be used for the three bands.

By connecting a trimmer capacitor between terminals 2 and 3 of the PLL, a particular amateur or shortwave band can be located more readily. In this case one potentiometer is used to tune over the entire band and the second potentiometer is used for bandspread tuning within the band.

An amplifier is a definite aid in improving the sensitivity for this simple direct-detection receiver. It is wise not to use an amplifier that can go into self-oscillation; be certain that any amplifier with tuned input and output circuits is properly neutralized before it is connected to the input of the phase-locked loop.

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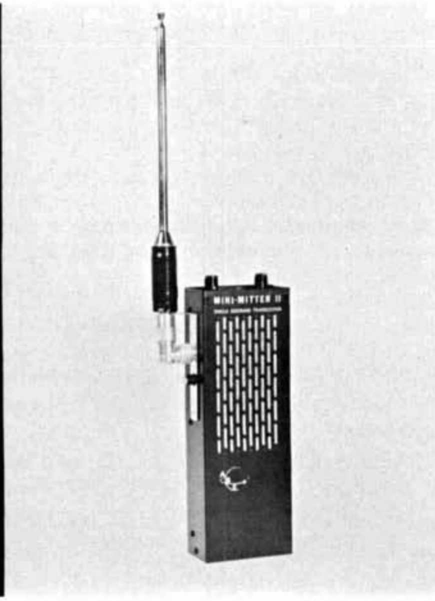


Mini-Mitter II

This miniature ssb transceiver for 40 and 80 puts the fun back into amateur radio

Ken Pierce, W6SLQ, 886 San Rafael Avenue, Mountain View, California 94040

Another page in the log book. Time, 2:13. Just moved off the net, traffic complete. Shall I go back to the net or just shut down; A kilowatt just to work 200 miles; what a waste of power. Someone calling me? Another kW? Must be from the sound of the signal. What did he say? Walkie talkie – on 40 meters? I don't believe it.

Those were the musings in my mind that Saturday afternoon I first met Al Clark, W6IHY. A few minutes later I was at the door of American States Electronics, a small neat building in Mountain View, California.

Al, a very affable fellow, showed me around the plant. With justifiable pride he handed me the Mini-Mitter II. This little handful is a complete ssb transceiver that weighs in at 3 pounds, complete with self-contained battery power supply. Unbelievable. I had heard the signal strength and quality of the signal, so I had to believe it.

Al gave me a chance to put it on the air. The signal strength and quality reports were excellent. I worked stations from 300-to 600-miles away with the same consistent reports. I had to have Mini-Mitter II for my own – what did I have to do to get one?

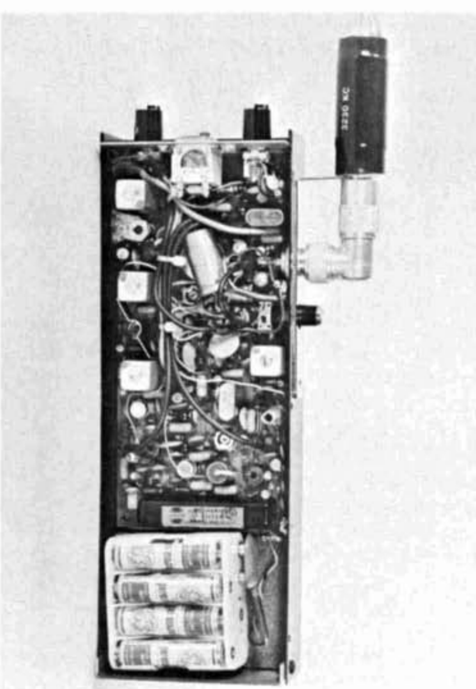
The answer to that question proved to be interesting, and to me, delightful. This transceiver is available in kit form for $149.95, complete. The accessory whip antenna is $7.95. I wondered if I could build the unit and make it work as well as the one I had in my hand. I looked over the kit and wiring instructions and came to the conclusion that it was perfect for me.

Do not be mislead, the unit contains a high-density printed-circuited board, about the size of your hand, that contains all the pertinent parts. In the next few hours I was to learn what Al meant by the term, "high-density board."

On the way home, with the kit under my arm, many second thoughts were running though my head. Could I put it together? Would it work? Was the set of instructions as good as I thought? Then I got home and opened the box (giving second priority to my usual Saturday chores), "I" started putting the transceiver together.

I followed the instructions to the letter, no playing it by ear. When I finished, I followed the simple alignment instructions and I was on the air. On-the-air contacts confirmed that it is really easy to have a good quality ssb signal.

The Mini-Mitter II printed-circuit board contains three ICs, 15 transistors and 15 silicon diodes. A Collins mechanical filter with crystal-controlled carrier frequency places the carrier at the proper place on the slope of the filter. This gives



They call it a "high parts density printed-circuit board," but construction is not difficult.

mini-mitter II

frequency	crystal controlled on any 40- or 80-meter frequency
mode	upper or lower sideband
rf output	4 watts PEP
sideband suppression	40 dB or more
output	50 ohms nominal
sensitivity	less than 1 uV for 10-dB signal-to-noise ratio
selectivity	2.1 kHz at 6 dB down
audio output	0.2 watts nominal
power supply	10 volts (eight AA penlight cells, self contained)
size	9 7/8 x 3 3/8 x 1 3/4 inches
weight	44 ounces
price	$149.95

American States Electronics, 1074 Wentworth Street, Mountain View, California 94040.

an audio passband of 350 to 2450 Hz, results in beautiful quality and retains the "presence" of the human voice. The tiny transceiver has many of the refinements of larger, more expensive rigs, including alc, agc, image rejection of 50 dB, 40 dB minimum carrier suppression and 50- to 75-ohm output.

With the whip antenna in place I wondered if I could work anyone just walking around the street. I worked stations as far away as Oakland and San Jose (about 30 miles). One mobile operator had to drive over to see the miniature transceiver for himself.

With such good results with the small whip, I wondered what I could expect from the larger portable antenna – the ASE 17 DL, priced at $66.95. Five states were logged with the portable antenna on its 20-foot mast and I never miss the opportunity to show my logbook to the kilowatt advocates.

I put the little Mini-Mitter II under my arm and went over to see Al again at the factory. I got the same warm welcome I received on my first visit. Al checked out the unit for me, measured the rf output, noted all those things that fascinate engineers, then gave it back to me. We were both satisfied with its performance. I am very proud of this little gem and use it extensively on 40-meter ssb.

ham radio

the ham notebook

electronic keyer notes

The electronic keyer described by VE7BFK in *ham radio*, November, 1969, is superb, and I highly recommend it to home builders. With a dual-lever key the dot memory and dash over-ride features make code operation a pleasure while the construction of the unit is a fine introduction to digital microcircuit techniques. The following notes describe some minor modifications to the original design that have proved worthwhile.

set ciruit

My keyer worked quite well as designed except for an annoying tendency to spawn an occasional extra dot. This problem was solved by reducing R14 from 4.7k to 1.2k ohms; this gives a set pulse of only 200 microseconds which is quite sufficient for reliable operation of the dot memory chain even with the supply line reduced to 2 volts.

keying circuit

The original keyer is all solid state and uses a switching transistor to key the transmitter. When grid-block keying is used, as is generally the case, the keyer ground is at a different potential than the transmitter ground. Apart from presenting a minor safety hazard I found that this practice made it difficult to keep rf energy from triggering the keyer. For this reason I substituted the reed relay and driver circuit shown in **fig. 1**.

Operate and release times are less than one millisecond, giving negligible shaping at any practicable keying speed. The resistor in the keying lead limits current pulses and prevents sticking contacts. I wound my own bobbin around a miniature reed capsule and ended up with a coil resistance of 60 ohms. This operated nicely with a series resistor of 82 ohms to recude the drain on the power supply; higher resistance relays should not need this resistor. The diode across the coil damps the spikes of back emf which might otherwise feed back into the circuitry and play hob with the timing.

monitor

The circuit as described had no monitor. **Fig. 2** shows the monitor in use in

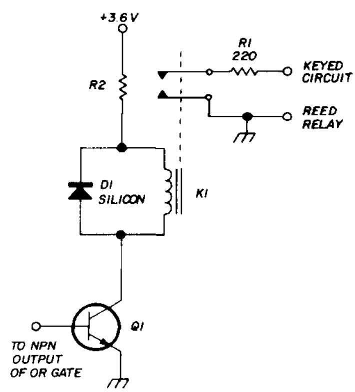


fig. 1. Relay driver circuit. Q1 may be any small-signal silicon type such as the 2N3643 or BC108 with 300 mW or greater rating. R2 is current-limiting resistor, not required if relay K1 has coil resistance greater than 100 ohms.

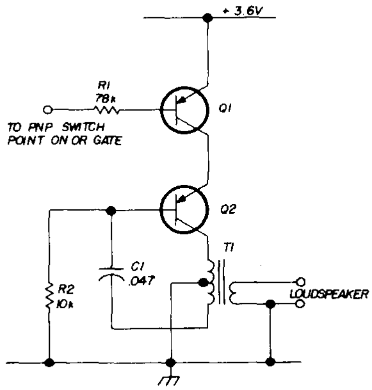


fig. 2. Monitor circuit. Transformer T1 is a transistor output transformer, 500 ohms center-tapped to 16 ohms. Q1 and Q2 are pnp small-signal silicon transistors such as the 2N3638 or BC118.

my keyer. It is a useful addition even if your transmitter has a built-in sidetone oscillator as it provides an audible check on keyer operation when setting it up. It also permits you to learn the squeeze-keying technique *before* you try it on the air. Transistor Q1 functions simply as a switch to key Q2 which is a form of *relaxation oscillator*. It may be necessary to juggle the values of R1 and R2 to get the best sounding note. The transformer is not critical and both the output and driver transformer from a junked transistor radio have been used with success.

components

Timing capacitor C3 in the original clock circuit is shown as a 1-μF electrolytic. This can be a source of trouble, and I recommend the use of a polyester 1-μF type at this point. A more suitable value for the speed control R7 will then be 100k ohms; R6 may also need to be increased, depending on the speed range that your own particular operation demands.

I used the Motorola RTL MC790P dual flip-flop and two MC724P quad gates as suggested by VE7BFK. These have worked very well, but experimenters may like to try the new TTL devices manufactured by Motorola and others. These devices claim a superior specification at about half the cost of the already reasonably priced RTL devices. If you want to run the keyer from a battery supply follow VE7BFK's advice and use the special milliwatt ICs with the original solid-state keying.

If you don't want to use the printed circuit board specified in the original article I would suggest the use of Vector board made especially for dual-in-line packs. The board has the power and ground rails already set up, and wiring is much less of a chore than it is with standard Vector board.

Barry Kirkwood, ZL1BN

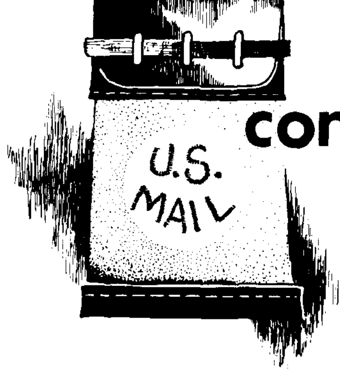
heath ten-minute timer

The Heathkit SB-630 Station Console incorporates a timer which uses a raucous 6.3-volt buzzer, Heath number 69-38. This buzzer has some very fine wire connections to its terminals, which appear to break off as a result of the vibration of the buzzer, mounted on a rubber grommet. Disassembly of the buzzer proved to be impossible without damage, and the unit was not sufficiently attractive to replace with an identical unit.

After some *value engineering* the matter was handled by putting a resistor from the 6.3-volt buzzer lead to the loudspeaker phono jack used on the phone-patch portion of the unit. This resistor can be from 30 to 100 ohms, depending upon the power capabilities of the loudspeaker, and the amount of sound desired. A junkbox resistor, therefore, proved to be more satisfactory than spending money to replace the damaged buzzer.

Incidentally, the instruction manual keeps mentioning a ten-minute interval for reminding the operator to identify. Unfortunately, this will lead to violation of the FCC regulation. The timer should be set for some shorter time so that the identification will be made before 10 minutes have expired, even if the other station is transmitting at the end of the ten minutes.

Bill Conklin, K6KA



comments

smith charts

Dear HR:

I was delighted to see your fine article on the use of the Smith chart in the November, 1970 issue. Your generous sprinkling of the step-by-step instructions with full-fledged graphs to illustrate each use should go a long way toward inviting many amateurs to learn how to use this powerful tool. Perhaps your article will become the implement for helping them come to grips with the complex Z, and to discover that Z often has a jX as well as R.

My daily work involves approximately equal use of the Smith Chart and the slide rule, and as a result I am equally at home with many phases of its use. I can therefore appreciate the opportunity you are presenting to those who might otherwise never discover that all those circles aren't really all that difficult.

Without intending to detract in any way from the otherwise excellent presentation, I would, nevertheless, like to call your attention to two basic errors. One is in the matching-stub example and the other in handling attenuation through a lossy line.

In the matching-stub problem, the procedure is in error because impedance operation is used, rather than admittance. Stub use implies *shunt* connection to the line, and indeed, the schematic diagram shows the shunt connection. Thus there can be no disagreeing that admittance procedure is required to obtain a correct answer to the problem as presented.

To illustrate the required changes, refer to the Smith chart in **fig. 1** above. The proper steps are as follows:

1. Normalize the load impedance
$Z_L' = (32 + j20/)/50 = 0.64 + j0.4$

2. Locate this point on the chart and draw a line through it and the chart center, extending the line through the peripheral scales in the negative, or bottom, portion at 0.336λ ($a° = -62°$).

3. Construct a constant-gamma circle through Z_L, on through the admittance point Y_L, and intersecting the unity *conductance* circle (G = 1) at point A.

4. Draw a line from the chart center through point A to the outer scale at 0.348λ (or $a° = -71°$). L_d, the distance from the load to stub, is the distance from 0.336 to 0.348.
$L_d = (0.348 - 0.336) = 0.012\lambda$
$a° = 71° - 62° = 9°$ (4.5 electrical degrees)

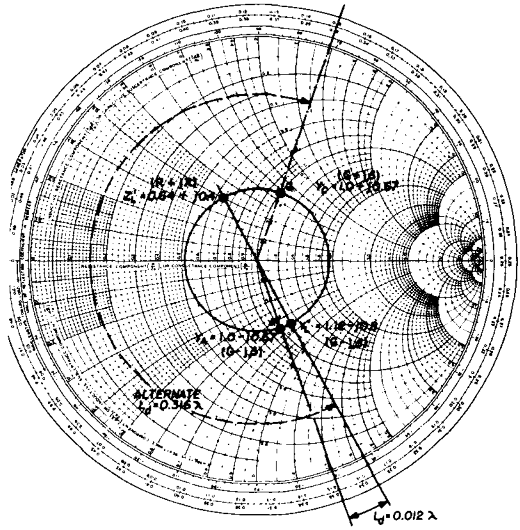
5. To find the length of the stub, determine the amount of susceptance necessary to match out the load. The required susceptance is the difference between the susceptance at point A and the susceptance at the center of the chart. The susceptance at point A is $-j0.67$. The required stub susceptance is

$$\beta = +j0.67$$

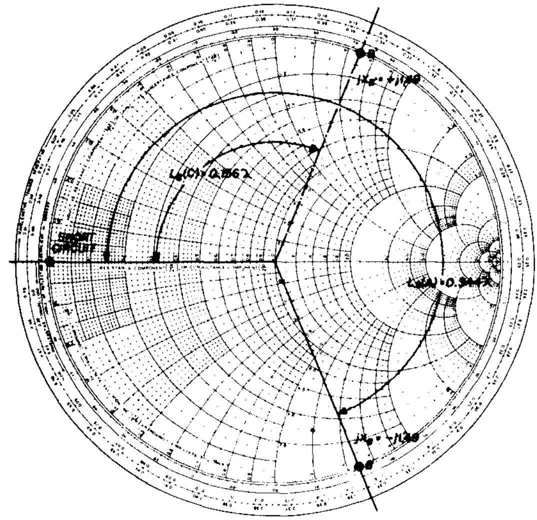
6. Determine the equivalent stub reactance by taking the reciprocal of the susceptance (as described in *example 4,* page 21, November, 1970)

$$X = -j1.49$$

7. Locate the reactance $-j1.49$ on the rim of the chart (point B). Determine the distance between the short-circuit point and the required reactance (point B) along the "wavelengths toward generator" scale. $L_s = 0.344\lambda$. ($a° = 248°$, 124 electrical degrees).

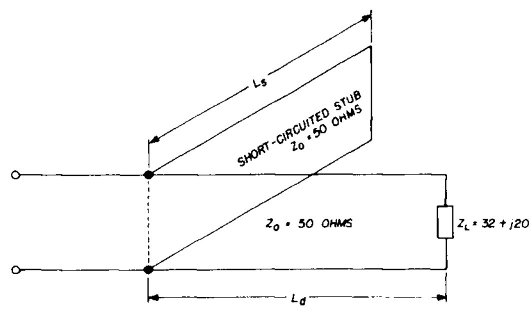


A



B

fig. 1. Using the Smith chart to find matching stub length and location.



C

For practical reasons it may not be possible to place a shunt stub only 4.5° from the load. It may be necessary to increase the distance L_D to the next point where G = 1 (not R = 1), represented by point C, **fig. 1.** In this case L_D would be measured, clockwise from 0.336 through 0.50 to 0.151. Using the reflection coefficient scale, from a° = −62° to 180° plus 180° to +71°, which totals 227°R, or 113.5 electrical degrees. This represents 0.316λ. This will require a +jX stub, length shown as L_s(C), of the same numerical reactance value as before.

lossy lines

Turning now to the lossy-line problem in which the line attenuation is 2.0 dB, the error concerns the method used in determining the corrected voltage coefficient for the lossy condition. You have stated incorrectly in both **Steps 4** and **5** that the voltage reflection coefficient in the lossy case is 2.0 dB lower than that of the lossless case. This is incorrect because the voltage reflection coefficient varies directly with *power ratio* of one-way line attenuation and *not* the voltage ratio.

Your ρ^* correction factor of 0.794, derived from

$$2.0 \text{ dB} = -20 \log_{10} \frac{E_{output}}{E_{input}}$$

yields an input reflection coefficient for line attenuation of exactly 1.0 dB; *not* 2.0 dB. The correct correction factor is 0.631, derived from

$$2.0 \text{ dB} = -10 \log_{10} \frac{\text{Power out}}{\text{Power in}}$$

This is evident because by using the radially-scaled parameter titled "Transmission Loss, 1-dB steps," the interval

*ASA standards have adopted ρ (rho) to represent the magnitude of the reflection coefficient.

shown on your plot (to represent 2.0 dB) measures 1.0 dB on the scale. Plotting off an actual 2.0 dB with the 1 dB-step scale brings the Z_L (lossy) to 1.08 + j1.05, which indeed has a reflection coefficient of 0.631.

According to Phillip Smith, inventor of the Smith chart, "Since the propagation path is common to both the forward and reflected wave energy, the latter, in its backward path to the initial point of entry, will be attenuated in the same ratio as was the incident wave energy. At the initial point of entry the power reflection coefficient is, thus, a measure of the two-way transmission loss, expressed as a power ratio. One-half of this, therefore, represents the one-way transmission loss, viz.,

$$dB = \tfrac{1}{2}(-10 \log_{10}\rho^2) = -10 \log_{10}\rho \cdot \cdots$$

The line in **example 8** has a one-way attenuation of 2.0 dB. That quantity of power which will ultimately be reflected back to the input suffers a 2.0 dB loss in the forward direction and another 2.0 dB during the return trip. The power returning to the input (ρ^2) is therefore 4.0 dB below its original level at the beginning of the journey. Thus ρ^2 is 4.0 dB below what it would be with a lossless line, and so also would be ρ. Therefore, to derive the ρ correction factor, we may write (all logs to base 10):

$$\begin{aligned} -10 \log \rho^2 &= 4.0\text{ dB} \\ -\log \rho^2 &= 0.4 \\ \rho^2 &= 0.398 \\ \rho^2 &= \sqrt{0.398} = 0.631 \end{aligned}$$

But a *one-way* loss must be, as Smith has stated:

$$\begin{aligned} \tfrac{1}{2}(-10 \log \rho^2) &= 2.0\text{ dB} \\ -\tfrac{1}{2} \log \rho^2 &= 0.2 \\ -\log \rho &= 0.2 \\ \rho &= 0.631\text{, and not } 0.794 \end{aligned}$$

However, $0.794^2 = 0.631$; it is evident that the corrected input reflection coefficient for the line with 2.0-dB attenuation terminated with a load whose reflection coefficient is 0.68 will be the product of 0.631 x 0.68 = 0.429, in contrast to the result of 0.54 as indicated in the article.

Walter Maxwell, W2DU
Dayton, New Jersey

triangle antennas

Dear HR:

The triangle antenna is a good antenna. However, I always wonder why loop-antenna articles never include the fact that a full-wave loop has 2-dB gain over a dipole ("Quads and Yagis," *QST*, May, 1968). A square quad or triangle delta configuration probably won't provide all of the 2-dB gain, but then cost and mechanical considerations generally take precedence over theory.

Wayne W. Cooper, K4ZZV
Miami Shores, Florida

teacher exchange

Dear HR:

I teach electronic, electrical, radio and tv, and mathematics subjects at various levels at the County Technical College in Norfolk, and I am seeking a one-year teacher exchange with an American teacher. I have been selected on this side but so far we have been unable to find an American teacher (and family) desirous of working and living in England (but retaining U. S. salary) for a year beginning August, 1972.

If any of your teacher readers (perhaps, but not necessarily a radio amateur) would be interested in an inexpensive one-year "holiday" in England, I invite them to write to me or contact my "exchange manager," WB2FBF, who will answer any local queries. Official details and application forms in the U. S. are available from the Office of Education, Washington, D. C. 20202.

David Lake, G3ZCA
County Technical College
Tennyson Avenue, King's Lynn
Norfolk, England

More Details? CHECK—OFF Page 120

coax-cable leakage

Dear HR:

I read with interest VE7ABK's article in the March, 1971 issue. His comment about shielding (or lack of it) in RG-8/U brought to mind a fact that seems to be little known among amateurs. Common single-braid coaxial cables such as RG-8/U leak like a sieve.

Many times this leakage does not matter, or the effect is not noticed; however, in some cases, as with repeaters or impedance bridges where the oscillator and detector levels are more than 150 dB apart, lack of shielding in ordinary coaxial cables and connectors is of major importance. Double-braid cables such as the old RG-9/U and RG-55/U, and the newer versions, RG-214/U and RG-223/U, are made for just such circumstances. Also, type-N connectors are much better than BNC.

Ron Guentzler, W8BBB
Ada, Ohio

rf speech clipper

Dear HR:

There are two errors in the schematic diagram of the rf clipper described in the August, 1971 issue (page 19). The fixed capacitor across the rf input to the gate of the 2N5248 source-follower stage should be 100 pF instead of the 0.01 μF shown. The 100-pF capacitor pads the tuning range of the Arco 403 trimmer to provide 130 pF, the resonant tuning capacitance for the mechanical filter.

The second error is in the 2N2222 amplifier stage. The emitter of this transistor should be bypassed with a 0.01-μF capacitor to provide sufficient ac gain to allow clipping. It has come to my attention that it may not be possible to develop sufficient gain with the untuned 2N2222 collector. This is due to a combination of lower gain devices and/or the ommission of the source-follower input stage when used in a transmitter with high-frequency crystal filters (such as the Heath SB400 series).

In such cases a 455-kHz resonant circuit with a loaded Q of 10 to 20 is required in place of RFC3. This source follower provides +10 dB power gain (voltage gain slightly less than unity). Without this stage there may be lack of drive to the clipping diodes. For Heath and Kenwood transmitters, an additional power amplifier stage should be added between the 2N2222 amplifiers and the clipping diodes.

One other point: the part number of both RFC1 and RFC2 in **fig. 1** should be 3E2A, not 3K2A.

Bruce Clarke, K6JYO
Fullerton, California

ac line cords

Dear HR:

A recent *ham notebook* item from K6JYO described a "safer suicide cord." Many of us are guilty of removing ac power cables from wall outlets by the simple and quick expedient of jerking the cable, rather than walking over to the ac plug. One of the dangers involved, unknown to most of us, is that when pulled from some distance, the cable acts like a whip — and you can LOSE AN EYE! I know of one such case. It might be wise to stop this practice and to remind others as well.

Frank Hatanaka, W6EG

using the mailing wrapper

Dear HR:

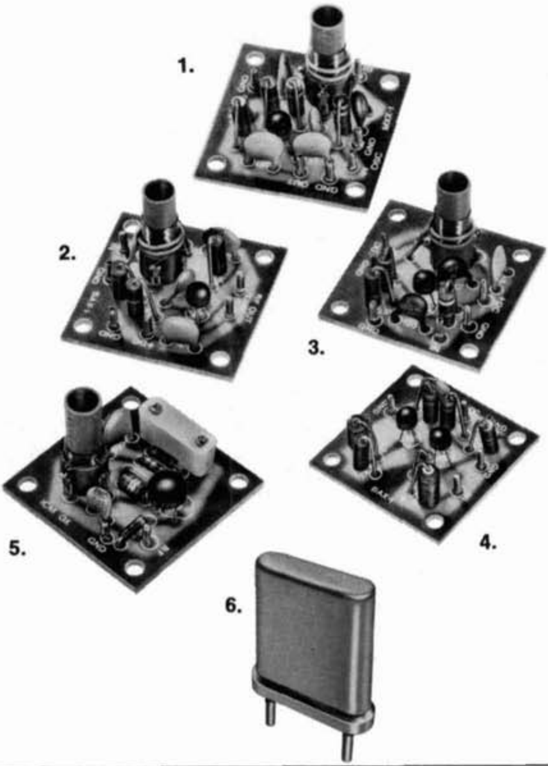
When my copy of *ham radio* arrives each month I slit the mailing wrapper on the open-page side and leave it attached to the magazine. On the wrapper I write the title and page number of any article that interests me. After much handling, particularly if I build something from the issue, the wrapper is well stained with solder flux and finger marks. When I remove the wrapper I have a nice clean magazine to put with the rest of my *ham radio* file.

Robert J. Farnum, W4PWC
Miami Shores, Florida

for the experimenter!

INTERNATIONAL EX CRYSTAL & EX KITS

OSCILLATOR • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER



1. MXX-1 TRANSISTOR RF MIXER
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering)........................**$3.50**

2. SAX-1 TRANSISTOR RF AMP
A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering)........................**$3.50**

3. PAX-1 TRANSISTOR RF POWER AMP
A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw, depending on the frequency and voltage. Amplifier can be amplitude modulated. Frequency 3,000 to 30,000 KHz..**$3.75**

4. BAX-1 BROADBAND AMP
General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL, Experimenter or Amateur........................**$3.75**

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Crystal controlled transistor type. Lo Kit 3,000 to 19,999 KHz, Hi Kit 20,000 to 60,000 KHz. (Specify when ordering)................**$2.95**

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Available from 3,000 to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ± .02% when operated in International OX circuit or its equivalent. (Specify frequency) **$3.95**

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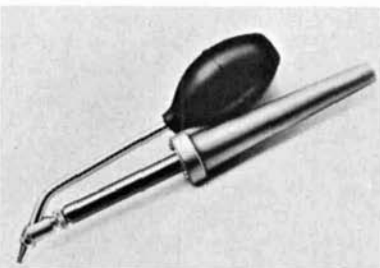
More Details? CHECK—OFF Page 120

new products

desoldering iron



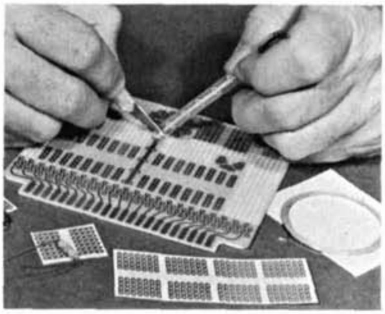
Weller has introduced a new hollow-tipped desoldering iron designated the DS-40. A vacuum bulb removes solder melted by the tip; this aids parts removal from printed-circuit boards or conventional wiring.

This new tool can also be used to solder in new components once the old ones have been removed. The hollow tip fits over wire leads giving 360° contact. This gives more uniform heating and better solder joints.

The unit is designed for professional as well as amateur applications. Replacement tips are available in a variety of sizes and a three-wire version is also available. The standard two-wire version is sold with a tip and vacuum bulb for $14.50.

Use *check-off* on page 120 for more information or write to Weller, 100 Wellco Road, Easton, Pennsylvania 18042.

circuit-stik



A new concept of instant printed circuits now permits you to rapidly build projects directly from a schematic diagram. This new approach to printed circuits consists of a complete family of circuit subelements and associated circuit materials. With instant printed circuits there is no messy etching, and in most instances, no need to drill any holes.

The instant printed-circuit subelements consist of printed conductive patterns on a very thin epoxy-glass board backed with pressure-sensitive adhesive. Subelements are available for all types of integrated circuits, transistors and other components. Any combination of circuit element configurations can be mixed on one board; The circuit subelements are all pre-drilled with holes on a 0.100-inch grid to match the pattern of 0.100-inch Vector board.

As an example, assume you are building a project using a 10-lead, TO-5 integrated circuit. Simply pick up the matching subelement, strip off the protective backing and stick it in position, matching the holes in the printed-circuit subelement with holes in the Vector board.

The printed-circuit subelement has pre-drilled holes to accept the integrated circuit leads and provisions for connecting components or leads to the integrated circuit. From this point, there are two basic ways to complete the circuit; or a third approach that uses a combination of the first two. One way to complete the

More Details? CHECK—OFF Page 120

circuit is simply to use jumper wires and component leads. Or, you can use conductive tape for making inter-connections and donut pads for terminating component leads.

Just place donut pads at points where you wish to terminate components. The components terminated on the donut pads should be mechanically secure without support from the pad. That is, resistors and capacitors should be pushed through holes in the board so that the component rests firmly on the Vector board.

To use the conductive tape, hold one termination point with an X-acto knife and strip the protective paper as the tape is laid down. The knife blade is then moved to the opposite termination, pressed down, and the tape is popped off with a quick tug. For best adhesion, roll the tape down with the side or heel of the knife or other burnishing tool. The adhesive on the copper tape is electrically conductive, and, provided it is burnished for good adhesion, no soldering is needed for temporary patches and connections. However, to eliminate any possibility of opens or intermittents, a drop of solder is highly recommended at termination points.

Various assortment packets of Circuit-Stik are available from Circuit Specialists Company, Box 3047, Scottsdale, Arizona 85257 at prices of $5.50, $7.95 and $9.95; add 35 cents for shipment by air mail. For more information use *check-off* on page 120.

hep semiconductor catalog

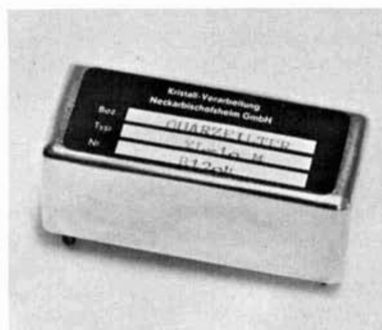
More than 31,000 semiconductor devices are cross-referenced to HEP replacements in the new 1971 Motorola HEP Semiconductor Cross Reference Guide and Catalog. Included in the catalog are 1N, 2N, 3N, JEDEC, manufacturers' regular and special "house" numbers and many international devices, with particular emphasis on Japanese types.

Four hundred and seventy-one HEP

items are included in this guide, including kits, books and accessories. As in previous editions, the Motorola HEP devices are listed by type number with a packaging index, device dimension drawings and selection guide information.

This cross-reference guide and catalog is available free at local HEP suppliers throughout the country. It should be of particular interest to the amateur, hobbyist-experimenter and the professional service dealer since it gives the minimum/maximum ratings and the electrical characteristics for the HEP devices as well as cross-reference information.

no-ring crystal filter



An extremely-sharp ten-pole ladder filter for narrow-band CW and pulse operation has been introduced by Spectrum International. The new model XL 10M is manufactured by KVG of West Germany and eliminates the ringing effect commonly found in some narrow bandwidth crystal filters by a near-Gaussian response to -6 dB. The filter comes with built-in input and output transformers in its hermetically sealed enclosure. The filter features a bandwidth at -6 dB of 500 Hz, symetrical around a center frequency of 9 MHz and with a shape factor (6:60 dB) of 2. It has a maximum insertion loss of 10 dB and a minimum ultimate rejection of 80 dB. It sells for $59.95.

For complete technical specifications write to Spectrum International, Box 87, Topsfield, Massachusetts 01983 or use *check-off* on page 120.

More Details? CHECK–OFF Page 120

audio filters

Kojo audio filters can greatly improve reception on all receivers by removing high-frequency audio hiss, background noise and ssb *buckshot*. The ssb filter uses a low-pass design with sharp cutoff to provide rejection better than 30 dB at all frequencies above 3500 Hz. The ssb filter is specifically designed for placement in the low-impedance line to headphones or speaker.

The Kojo cw filter has a spot frequency of 780 Hz and a passband of 1100 Hz with a reference level 40 dB below the signal level at the design frequency. The peak of the passband is 100 Hz wide at the -3 dB points. The cw filter is designed for low-impedance input and high-impedance output; high-impedance crystal-type earphones are recommended.

The Kojo audio filters use top grade coils and quality components, and are available in kit form or ready-to-use deluxe unit enclosed in a cabinet. The cw filter kit is $7.95 (deluxe cw filter, $15.95); the ssb filter kit is $11.95 (deluxe ssb filter, $19.95). Postpaid from The J. Lynch Company, Post Office Box 7774, Phoenix, Arizona 85011. For more information use *check-off* on page 120.

allied catalog

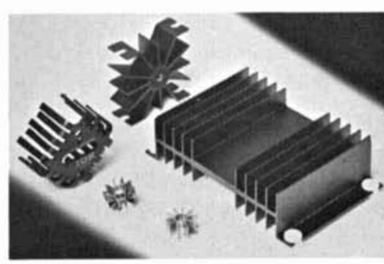
The new 132-page, *1972 Electronic Parts and Accessories Catalog* has just been announced by Allied Radio Shack. The catalog lists thousands of hard-to-find electronic items, accessories and repair components in addition to the complete line of Knight-Kit, Science Fair, Allied, Realistic, Archer, Micronta and Radio Shack brand products.

The new catalog, numbered 215, is designed for the amateur, hobbyist, kit builder and electronics professional. It is available free on request from Allied Radio Shack, 2725 West Seventh Street, Fort Worth, Texas 76107 or by using *check-off* on page 120.

electronics hardware

International Rectifier Corporation has introduced a new line of semiconductor hardware for home experimenters. The line includes integrated-circuit and transistor sockets, universal heat dissipators, heat exchangers, semiconductor mounting kits and a dual-in-line component carrier.

A total of eight sockets are available, including three matched integrated-circuit sockets for 8-, 10- and 12-pin TO-5 case styles. Prices are 65 to 75 cents in assorted quantities. Low profile, dual-in-line IC sockets will be available in 14- and 16-pin sizes at 80 to 99 cents in assorted quantities. This is the industry's first full assortment of sockets for every hobbyist purpose.



The International Rectifier universal transistor sockets are designed to be used with in-line plastic SCRs, triacs and some 19 transistor bases. Sockets for power transistors feature high reliability and brass/cadmium plated contacts, with a PC board drilling template provided with each socket.

The Diamond Line of semiconductor hardware will also include a wide range of heat exchangers to control semiconductor operating temperatures and extruded

More Details? CHECK—OFF Page 120

aluminum heat sinks designed to deliver increased power dissipation per unit of cost.

The heat exchangers are available with universal hole patterns for various semiconductor types and TO-5 case configurations. A universal heat dissipator for all power tab plastic transistors, SCRs and triacs will be introduced to the line. Priced at 68 cents, the clip and dissipator assembly may be mounted vertically or horizontally as circuit density dictates.

Mounting kits for transistors and rectifiers will include hardware, insulating mica washers, wiring lugs and other components for application requiring electrical isolation.

A component carrier for mounting discrete components and integrated component packages rounds out the semiconductor hardware line and enables the hobbyist to create his own dual-in-line ICs. The carrier plugs into standard 0.100 x 0.300-inch dual-in-line sockets or into printed-circuit boards with the same grid pattern.

The component carrier is available with a snap-on cover. Clearance for components within the cover is keyed to accept a broad range of component and package sizes. Heavy duty pins accept wires and leads to size 24. Available at your local electronics dealer. For more information use *check-off* on page 120.

radio-electronics hobby projects

This new book by the editor of *Radio-Electronics* magazine provides a unique assortment of 32 practical electronics projects for the experimenter. For technicians the book includes projects on a fet dual-trace scope switch, a 3-way waveform generator, a scope calibrator, an audio tone-burst generator, a low-voltage electrolytic tester, a dot/bar generator and an fm stereo multiplex generator.

For the hi-fi buff there are multiplex tuners and adapters, stereo amplifiers and modifiers, mixers and speaker systems.

Musically-inclined experimenters will find vibrato and tremolo devices, rhythm lights plus a complete synthesizer. The auto enthusiast will find devices such as an electronic ignition system, a road icing alarm and an automatic windshield-wiper pause-controller. For the home handyman there are timers, a tape-slide synchronizer, a phototach, and an IC sound relay, among others. Each project includes a detailed parts list and a complete schematic or working drawing, plus explicit instructions on building, calibrating and operating the completed unit. 192 pages, many illustrations. $6.95 hardbound, $3.95 paperbound from TAB Books, Blue Ridge Summit, Pennsylvania 17214. For more information use *check-off* on page 120.

midget ratchet kits

The Chapman Manufacturing Company has a complete line of midget ratchet kits that should be especially interesting to the home electronics experimenter. These kits include all types of difficult-to-find drive tools including Bristol multiple-spline adapters, Allen head adapters, Phillips head adapters, Reed and Prince adapters and slotted-head adapters, as well as a ¼-inch drive adapter. The Allen head adapters are available in both English and metric sizes.

The Chapman adapters are constructed of high-strength chrome nickel molybdenum alloy steel and are precision made to insure a proper fit. Their dual-

More Details? CHECK—OFF Page 120

purpose knurled "spinner tops" allow for quick finger tightening of threads and for instant "push-down" removal of the adapter from the ratchet. The Chapman ratchet, designed to function in confined areas, operates with minimum movement of the handle.

The 6320 tool kit shown in the photograph above includes 1 midget ratchet, 1 extension, 1 screw-driver handle, 12 Allen hex adapters, 2 slotted-head adapters, 2 Phillips head adapters and a ¼-inch drive adapter. The 6320 kit is priced at $12.95 at your local distributor. Manufactured by The Chapman Manufacturing Company, Route 17, At Saw Mill Road, Durham, Connecticut 06422. For more information use *check-off* on page 120.

new alkaline batteries

A new generation of alkaline batteries, so good that they can outperform all previous types by as much as 20 to 25 per cent, has been introduced by the Mallory Battery Company. The new Duracell* batteries have higher energy capacity than any other alkaline batteries available up to now, made possible by an entirely different internal construction, with fewer parts allowing for an increased volume of energy-producing materials in the battery.

Featuring a new copper and black label design, the batteries will be manufactured in all popular sizes for use in radios, cameras, flashlights, tape recorders, and other consumer products. Available at your local dealer.

*Duracell is a registered trade mark of P. R. Mallory & Co., Inc.

ssb transceiver

The Robyn International Model 500 high-frequency ssb transceiver features 6-digit frequency readout with 100-Hz accuracy. The transceiver runs 500 watts PEP on all bands, 80 through 10 meters and boasts a complement of over 125 semiconductors and six vacuum tubes in addition to the six Nixies in the digital readout. An ac power supply, speaker and microphone are included in the price of $895; an optional 12-Vdc supply is available.

For more information write to Robyn International, Box 478, Rockford, Michigan 49341 or use *check-off* on page 120.

vhf scaler

The new Dycomm digital vhf frequency divider/prescaler, the model PSU-13, is a high-sensitivity unit with a divide-by-ten scaling factor. The unit operates over a minimum frequency range of 10 to 240 MHz. Inherently sensitive, it will operate properly throughout its frequency range with input levels under 500 mV, and is guaranteed to operate at 180 MHz with an input level of 100 mV.

Advanced circuitry and design are featured in the PSU-13. The heart of this circuitry is a custom medium-scale integration integrated-circuit chip. Other notable features include a high output level of 2 volts peak-to-peak (minimum) across an open circuit, with typical output levels of 3.5 volts. This feature is enhanced by a capability to drive up to 2 feet of coaxial output cable while measuring or dividing frequencies in excess of 150 MHz. The PSU-13 has proven extemely satisfactory when used as a prescaler for Monsanto, Heath, Hewlett-Packard and other counters. Those not owning counters may use the PSU-13 with a calibrated communications receiver to obtain relatively accurate fre-

More Details? CHECK—OFF Page 120

quency measurements. The PSU-13 will also serve to sync vhf signals with oscilloscopes having frequency responses in the 10- to 30-MHz range.

Sold complete and ready to operate (not a kit), the PSU-13 is factory-adjusted for maximum sensitivity over its entire range. All adjustments are internal and need not be continuously varied by the owner.

Complete with self-contained 110-Vac power supply the PSU-13 weighs less than 1½ pounds. Attractively finished in modern flat black with white lettering and power cord, the PSU-13 is a natural complement for any existing frequency counter or communications equipment. $89.95 from Dynamic Communications, Inc., Post Office Box 10116, Riviera Beach, Florida 33404. For more information use *check-off* on page 120.

solid-state battery

The Mallory solid-state battery was developed as a highly reliable, extremely long shelf-life power source. The anode is lithium and the cathode a metal salt; the electrolyte is a lithium ion-conductive electronically insulative *solid.* The electrolyte also serves as the separator between the anode and cathode. The reactive nature of the materials used in these new batteries requires that they be hermetically sealed. The absence of any liquid in the system completely eliminates corrosion or gassing.

Construction of the new batteries is simple: the cells are fabricated by pressing the individual components together. The cells are stacked in a suitable container and sealed with a hermetic cap. No containers are needed as in conventional battery; this feature is ideal for high-voltage low-current power sources.

Mallory solid-state batteries are currently available only in research quantities. Interested parties should contact Mallory Battery Company, Tarrytown, New York 10591 for information and discussion of their particular requirements.

audio power module

Sinclair Radionics announced the first integrated circuit amplifier and preamplifier, the IC-10, nearly three years ago. Integrated circuit production technology has improved tremendously during this period of time, and now Sinclair/Audionics is proud to introduce the new IC-12.

The IC-12 offers a number of important advantages over the IC-10 and other similar devices now available at low cost to the hobbyist or commercial user. Perhaps most important is the useful amount of power available combined with very low harmonic distortion. Of equal importance is the ease in which the IC-12 may be used. Each IC-12 is supplied with a comprehensive instruction manual and a predrilled and etched circuit board. The circuit board accepts the required external components and the IC-12. The IC-12 is supplied in a 16-pin dual-inline package and may be used as an integral part of other circuitry. In addition, no tricky initial setup bias adjustments are required; simply add the additional external components and the IC-12 is ready to perform as a high-gain wideband audio amplifier.

The IC-12 is basically an operational amplifier with a quasi-complementary output stage. Power supply requirements are thus simple and inexpensive. The idle current consumption of the IC-12 is only 8 mA making batteries practical as a power source. The Sinclair PZ-5 supply is also ideal for use with the IC-12 and will power a pair to rated output. Aside from having simple setup and power supply requirements, the IC-12 is also very rugged and stable. No addtional heatsinking is required; an extruded aluminum fin is part of the package and is more than adequate under all normal operating conditions.

Power output of the IC-12 is 6 watts into 8 ohms (with a 30-volt power supply). Total harmonic distortion is less than 1% at any audible audio frequency. Frequency response is 5 Hz to 50kHz ±1 dB, depending upon the values of the

More Details? CHECK—OFF Page 120

external components. Total device gain is 90 dB; noise is −70 dB or better. The IC-12 is priced at $8.95 from authorized dealers, or from Audionics, Inc., 8600 Northeast Sandy Boulevard, Portland, Oregon 97220. For more information use *check-off* on page 120.

electronics self-taught with experiments and projects

Rather than simply telling you how to build some electronic gadget, and leaving you wondering why he bothered, this unique beginner's guide to electronics by Jim Ashe offers a much more worthwhile challenge, and greater assurance of gaining useful knowledge from its use. Written especially for serious experimenters, hobbyists and students this book shows *why* certain things are done, tells *how* devices and circuits work, and suggests innovations that spur the reader forward to more important work in electronics.

Using what he calls a "new" electronics, author Ashe puts things in a different light than other writers — a fresh perspective that helps you see certain fundamentals clearly and gain new insights into *today's* electronics. The author tells how to set up a home lab (for around $20.00 for those who are thrifty) and what tools and equipment are necessary.

The book divulges many fascinating tricks with ordinary garden variety diodes and transistors. Expensive, special-purpose types are not needed. In fact, the author continually stresses the importance of keeping things simple and inexpensive. There are circuits and projects using integrated circuits, plus communications devices, logic circuits, industrial devices and lab-type equipment the reader can build and calibrate himself. $7.95 hardbound; $4.95 paperbound, from TAB Books, Blue Ridge Summit, Pennsylvania 17214. For more information use *check-off* page 120.

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NEW LOW PRICES
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UL 914 Gate	80¢	10/5.50
UL 923 JK Flip-flop	$1.50	10/8.50
MC 790P Dual JK Flip-flop	$2.00	10/18.95
MC 890P Dual JK Flip-flop	$2.00	10/18.95
MC 789P Hex Inverter MC 724P Quad 2 Input Gate MC 799P Dual Buffer		$1.00 ea. 10/9.25

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MC 780P Decade	$3.00
MC 767P Quad Latch	3.00
MC 9760P Decade	5.00

ONE EACH OF 3 ABOVE $10.50

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7400 Quad 2 Input NAND Gate	65¢	10/5.95
7404 Hex Inverter	65¢	10/5.95
7441A Decimal Decoder/Driver	$3.50	10/29.95
NEW!! 7447 7 Segment Decoder/Driver	$3.10 each	10/$27.95
7473 Dual JK Flip-flop	$1.30	10/10.95
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741 Op Amp	$2.70	10/25.00
CA 3035 Linear Amplifier	$2.25	10/21.95

LM 309K 5V Regulator $3.75 10/$34.95

14 Pin Dual Inline socket terminals 25¢ 10/2.25

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Western Union facsimile machines, send and receive pictures and memos. Works on 115 v 60 cycles. Shipped with auto-start, auto-phase pos-to-pos, conversion instructions. 20 lbs. $19.95

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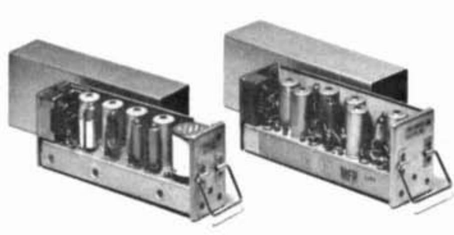
COMPLETE SET $9.95



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New
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Example: 28,649,800 Hz reads 28.6 MHz or 49.8 Khz. (Add the 10 Hz module to read 9.80.)

• A divide-by-ten prescaler is also available that operates up to 170 Mhz. Extend the range of any frequency counter — or use with the fm-36 for 6 meter or 2 meter use.

FM-36 KIT $134.50
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MINI-MITTER II SSB!
Portable Transceiver Kit
Handheld! QRP!

ALL TRANSISTOR SSB TRANSCEIVER KIT DESIGNED EXPRESSLY FOR THE HAM

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SSB GEAR THAT GOES WITH YOU! Introducing the new, delightfully wild MINI-MITTER II KIT designed especially for the Ham. Get it together in a few enjoyable hours of creative fun. Carefully engineered using the latest techniques this fully transistorized-solid state transceiver features commercial grade components, diode switching, a Collins Mechanical Filter along with the easy to follow instructions for assembly. The transceiver is powered by 8 Ni-Cad Batteries easily accessible through a hinged door at the rear of the case for recharging. The printed circuit board chassis and the complement of Field Effect Transistors along with Integrated Circuits ensures the highest performance, yet simplifies the circuitry for easy assembly. The tune-up procedure requires no special test equipment since all of the tuned circuits are pre-tuned at the factory and need only minor adjustment. For final setting and performance checks a receiver is recommended.

RECEIVER: Crystal controlled on 40 meters, supplied with 7215 or 7255 (specify). Crystal Tuning Range: Approx. .01% of frequency. Audio Power Output: .2 watts nominal. Sensitivity: Less than 1 uv for 10 db S/N. Selectivity: 2.1 KHz at 6 db. TRANSMITTER: 4 watts P.E.P. Carrier Suppression: -40 db or better. Modulation Freq. Range: 350 to 2450 Hz. Antenna Impedance: 50 ohms resistive.
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AMERICAN STATES ELECTRONICS

1074 WENTWORTH STREET MOUNTAIN VIEW CALIFORNIA 94040

short circuits

versatile vox

In **fig. 1** of this article, which appeared in the July 1971 issue, the transistors labeled 2N222A should be 2N2222A. Relay K2 should have been identified as a Hi-Vac type HC-1.

The receptacles on the output side of K2 should be labeled (from the top) "receiver," "antenna," and "P. A. tank." Also in **fig. 1** the terminal labeled "to keyline" should be disconnected from the solder dot in the line between S1B and K1A and instead connected to the junction of R3 and the 0.01-μF capacitor.

high-power linear

In **fig. 1**, page 59 of the April, 1971 issue, the control-grid bias supply should be grounded at the positive end of the 40-μF filter capacitor nearest the 25k potentiometer.

deluxe mosfet converters

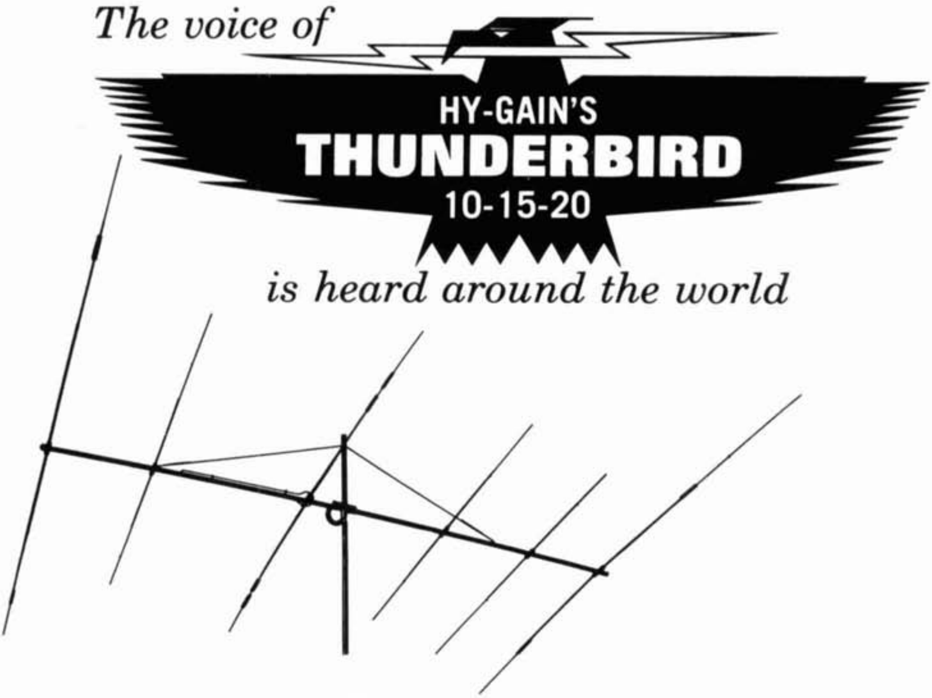
In **fig. 1**, page 42 and 43 of the February, 1971 issue there should be 10-pF capacitor between the rf amplifier on page 42 and the mixer on page 43. Piston trimmers are JFD VAM010W or Johanson 2951.

RTTY multimeter

In the circuit for the RTTY multimeter in **fig. 13** on page 29 of the March, 1971 issue, the 20k resistor should be 200k. Also, the duty cycles quoted are incorrect; these should be approximately 33% for Teletype and 29% for Western Union. Calibration remains correct for standard Teletype machines.

sonobaby

Two of the diodes in the Sonobaby fm transmitter in **fig. 2** on page 12 of October, 1971 issue are reversed — the two diodes on the right-hand side of the full-wave bridge should be turned around for proper operation.



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- **Thunderbird's "Hy-Q" traps** provide separate traps for each band. "Hy-Q" traps are electronically tuned at the factory to perform better at any frequency in the band—either phone or CW. **And** you can tune the antenna, using charts supplied in the manual, to **substantially** outperform any other antennas made.
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HAL DEVICES MODEL 1550 ELECTRONIC KEYER

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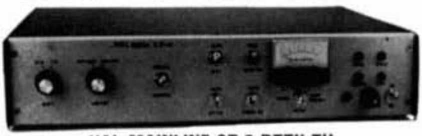

HAL MAINLINE ST-6 RTTY TU

Complete parts kit for the W6FFC ST-6 now includes all parts except cabinet. Only 7 **HAL** circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Screened table or rack cabinet $26.00. Boards and manual $16.50. Shipping extra. Wired units available.

HAL TOUCHCODER II KIT $55.00

Complete parts kit, excluding keyboard, for the W4UX CW code-typer. All circuitry on one 3 x 6" G10 glass PC board. Plug-in IC sockets. Optional contest ID available, $35.00. Watch for announcement of the new **HAL** code-typers, both Morse and RTTY.

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MAINLINE AK-1 AFSK KIT	27.50
HAL RT-1 TU/AFSK KIT	51.50

HOT CARRIER DIODES: HP2800 90¢, 12/$10.00 — Matched by **HAL** 4/$4.25
ZENERS: 1N4729(3.6v), 1N4733(5.1v), 1N4735(6.2v), 1N4738(8.2v), 1N4739(9.1v), 1N4742(12v) 1 watt 75¢
LINEAR ICS: 709N 75¢; 709L, 710N $1.25; 741N $1.50; MC1429G $3.75; MC1496G $3.25; MC1590G $5.60
DIGITAL ICS: FML923 90¢; MC723P 95¢
MRTL: MC788P $1.30; MC880P $3.50; MC890P $2.00; MC724P, MC725P, MC789P, MC792P $1.05; MC767P $3.30; MC771P $1.75; MC970P $3.30; MC9760P $5.45
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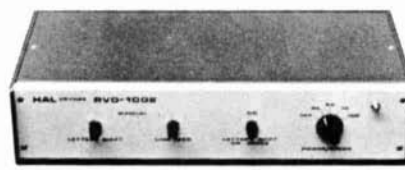
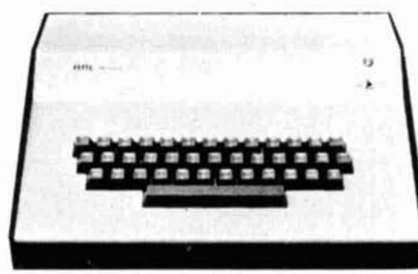
HAL DEVICES

ANNOUNCING





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- Selectable letters shift on space
- Manual control of line feed and letters shift.
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RVD-1002 (assembled)	$495
RVD-1002 R (rack mount)	$495
ST-6 (assembled)	$280
ST-6/AK-1 (assembled)	$320
TTY KEYBOARD	available soon

Modified solid state TV receivers will be available. Write for details.

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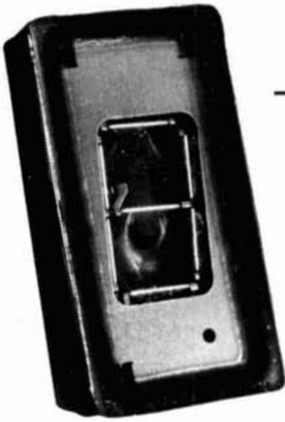

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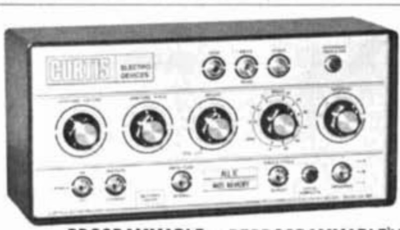

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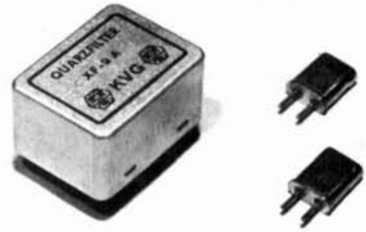

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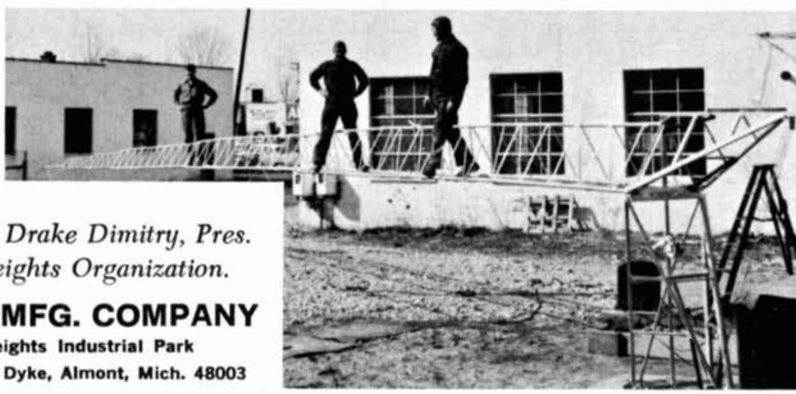

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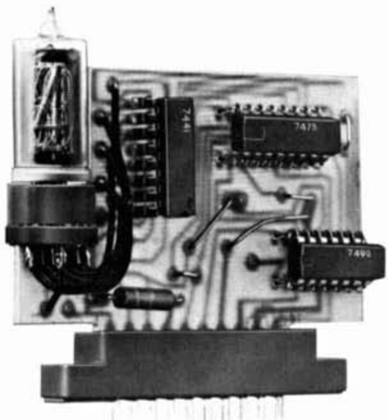

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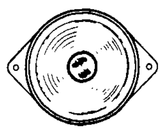

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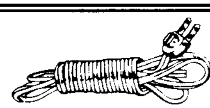

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TECH MANUALS — $6.50 each: URM-25D, LM-21, SP-600JX, R-274/FRR, OS-8C/U, CV-591A/URR, BC-639A, BC-779B. Hundreds more; 20-page list available 25¢ (coin). S. Consalvo, W3IHD, 4905 Roanne Drive, Washington, DC 20021.

ANTENNA BALUN — 1:1 KW unit, epoxy encapsulated with fittings; $7.95. Plate Chokes — 5KV/2AMP; $5.95. 4KV/800Ma.; $4.50 both 90uh. Dual filament choke, 30 Ampere shielded; $5.95. QSL brings all information. K. E. Electronics, Box 1279, Tustin, California 92680. Dealers welcome.

SAVE MONEY on parts and transmitting-receiving tubes. Foreign-Domestic. Send 25¢ for giant catalog. Refunded first order. United Radio Company, 56-HR Ferry Street, Newark, N.J. 07105.

METERS AND T.E. REPAIRED or calibrated. Write Hortons Repair Center, 1132 Connway, Heath, Ohio 43055.

AMATEUR SALES AND SERVICE before you buy it anywhere give us a chance to quote you a price. Alpha 70, Clegg, Regency, Robyn and Mosley are just a few of the leading names we sell. Write or call today. Amateur Sales and Service, 1115 Norris St., Raleigh, N. C. 27604. Tel. 1-919-833-2412.

"NIXIE" TYPE READOUTS (w/internal point) $2.90, sockets 55¢; 7441A drivers $2.50; 7490 or 7493 counters $1.75; 7475 latches $1.50; most 7400 series gates 35¢. DIP/IC sockets 1.2¢/pin. Everything brand new. SASE full info. WA1HSJ, Box 1, Corinth, Vermont 05039.

HEATHKIT SB620 scanalyzer. Mint condx. with manual $100. Ed Gerber, 1105 Harrison Street, Syracuse, N. Y. 13210. 315-472-3261 after 5 p.m.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for the largest event in the northeast, May 13th. Write WNY Hamfest, Box 1388, Rochester, N. Y. 14603.

TELETYPE #28 LRXB4 reperforator-transmitter "as is" $100; checked out $175. Includes two 3-speed gearshifts. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

WANTED R389, R390, R390A, R391, R220, Racal and 51S1 receivers. SWRC. P. O. Box 10048, Kansas City, Missouri 64111.

WORLD QSL BUREAU — See ad page 110.

21st ANNUAL DAYTON HAMVENTION will be held on April 22, 1972 at Wampler's Dayton Hara Arena. Technical sessions, Exhibits, Hidden transmitter hunt, Flea market and special program for the XYL. For information write Dayton Hamvention, Dept. H, Box 44, Dayton, OH 45401.

COLLINS 75S-1 w/500 Hz filter and 25 KHz calibrator $295. Navigator $85. 70E8A PTO $40. FT2409 200 Hz CW audio filter $13. Heath B-1 balun $4.00. PRD 175B attenuator, no gauge $4.50. 3E29 with socket $2. Miscellaneous other parts ask John Green, Box 1038, Boulder, Colo. 80301.

2-METER FM INOUE IC-20, Brand new. 10 watt, solid state, 12 channel, Xtaled, w/accessories, $220.00, Bob Brunkow, 15112 S.E. 44th Bellevue, Washington 98006.

ASK FOR FREE LIST of used Ham gear or for prompt personal attention on any new gear. Mail your order direct to VanSickle Radio, W9KJF, Indianapolis, Indiana 46205. 40 years experience.

LOOKING FOR FULL-TIME EMPLOYMENT? If you're a self-starter able to sell excellent Electronic Courses, there are jobs available throughout America and Canada. Write to Bill Welsh (W6DDB), 234 S. Orchard, Burbank, CA 91506.

RSGB MEMBERSHIP FOR 1972. Privileges include Radio Communication Magazine, Britain's finest amateur monthly, plus outgoing QSL Bureau. Join for only $9.60. Comtec Books, Box 592, Amherst, NH 03031.

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AMPEREX READOUT TUBE
Brand new
$3.00 ea.
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Amperex Tube
SN 7490
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All above **$6.75**

NIXIE TUBE POWER SUPPLY
From used eqpmt, OK. 115V input, solid state.
$4.95

2N404	3/1.00	2N990	2/1.00
2N706	3/1.00	2N2222	2/1.00
2N2218A	2/1.00	2N2907A	3/1.00
709 OP AMP	75¢	741 OP AMP	1.00

MM500 Dual 25 bit shift register	$2.50
MM502 Dual 50 bit shift register	3.50
MEM 511 MOS P-channel FET	1.00
1 amp diode 1000 PIV	8/1.00
1 amp diode 1500 PIV	4/1.00
2 amp diode 1000 PIV	6/1.00

COMPUTER ENCODER PC board, wired, with diodes & IC's. Removed from ASKII key-boards. $5.00 each

640 WIRED CORE MEMORY **$5.00** per frame

MODEL 33 KEYBOARD
$75.00
Brand new.
Made by **TELETYPE.**

MAGNOSTRICTIVE COMPUTER MEMORY
Magnostrictive delay line good for approx. 7000 bit storage. Details included. **$25.00**
800 Bit Storage — 1 MHz **$10.00**

MOTOROLA POWER TRANSISTOR 2N3448
NPNS • PWR • 115 watt • 80 volt **$1.50**

Please add postage for above items
Send 25¢ for Surplus Catalog . . .

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P.O. Box 62 E. Lynn, Mass. 01904

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December 1971

Please use before January 31, 1972

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Greenville, N. H. 03048

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ham radio

index to volume IV — 1971

This index covers all articles published in *ham radio* during 1971. The articles are listed alphabetically under each category along with the author, page number and month. Categories are: antennas and transmission lines; commercial equipment; construction techniques; fm and repeaters; integrated circuits; keying and control; measurements and test equipment; miscellaneous technical; power supplies; receivers and converters; RTTY; semiconductors; single sideband; transmitters and power amplifiers; vhf and microwave. Articles followed by (HN) appeared in the *ham notebook.*

antennas and transmission lines

audio

commercial equipment

construction techniques

fm and repeaters

integrated circuits

keying and control

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miscellaneous technical

power supplies

receivers and converters

RTTY

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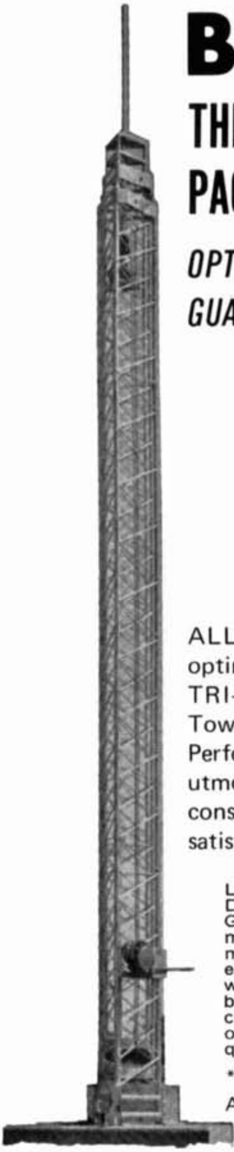
vhf and microwave



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OPTIMUM PERFORMANCE
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ALL NEW, engineered for optimum performance with TRI-EX's Certified* Antenna Towers & HY-GAIN's TOP Performance Antennas. The utmost in craftsmanship and construction for your satisfaction. . . .

Local Bank Financing - 15% Down or Trade-In Down - Good Reconditioned Equipment. Nearly all makes and models. Our reconditioned equipment carries a 30 day warranty and may be traded back within 90 days for full credit toward the purchase of NEW equipment. Inquiries invited.

*Certified Welders & Approved by L.A. City

LAE MW35 "STANDARD" Package (Free Standing Crank-Up Tower 9.5 Sq. Ft. - 50 MPH) (35 Ft.)
CDR AR-22R Rotator*
100 ft. RG-58/U Coax & Control Cable
Substitute 50 ft. free standing, add $100
Complete with one of the following antennas:

HY-GAIN TH2MK3	$259
HY-GAIN TH3JR	$259
HY-GAIN DB10-15A	$265
HY-GAIN HY QUAD	$280
HY-GAIN TH3MK3	$290
*TR-44 rotor w/cable add:	$ 30
HAM-M rotor w/cable add:	$ 60

LAE W51 "DELUXE" Package (51 Ft.) (Free Standing, 9 Sq. Ft. - 50 MPH)
CDR TR-44 rotor*
100 ft. RG58/U Coax & Control Cable
Substitute 67 ft. free standing, add $400
Complete with one of the following antennas:

HY-GAIN DB10-15A	$575
HY-GAIN HY QUAD	$590
HY-GAIN 204BA	$610
HY-GAIN TH3MK3	$610
HY-GAIN TH6DXX	$635

Free stdg. base incld. NO/CHARGE
*HAM-M rotor w/RG8/U add: $ 40

LAE LM354 "SUPER" Package (54 Ft.) (16 Sq. Ft. - 60 MPH)
CDR HAM-M Rotor
100 ft. RG8/U Coax & Control Cable
Substitute 70 ft. free standing, add $650
Complete with one of the following antennas:

HY-GAIN TH3MK3	$735
HY-GAIN 204BA	$740
HY-GAIN TH6DXX	$765

Freight PREPAID to your door in the Continental USA west of the Rockies. For shipment east of the Rockies, add $10.00. Substitutions may be made.... write for prices.

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HOME of LA AMATEUR RADIO SALES

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a winning pair....the "Kenwood twins"

THE MOST EXCITING RECEIVER AND TRANSCEIVER TO ENTER THE AMATEUR SCENE IN RECENT YEARS. THE KENWOOD R-599 SOLID STATE RECEIVER AND T-599 HYBRID TRANSMITTER HAVE ESTABLISHED NEW STANDARDS OF PERFORMANCE, RELIABILITY, FLEXIBILITY, STYLING AND VALUE.

THE R-599 RECEIVER: .5 microvolt sensitivity (amateur bands 1.8-21.0 MHz) • Dial readout to 1/2 kilocycle • Special detectors for SSB, AM, and FM • Transceive operation with T-599 • Built-in 100 kc and 25 kc crystal calibrator • Built-in 500 cycle CW filter • Provision for two meter and six meter coverage with optional accessory self-contained converters • Advanced "Space-Age" styling • Adjustable threshold squelch • The price . . . only $329.00*

THE T-599 TRANSMITTER: Clear, stable, selectable side-band, AM and CW • 4-way VFO Flexibility plus Receiver Incremental Tuning (RIT) when used with the R-599 • Amplified ALC • Built-in VOX • Full metering, including cathode current, plate voltage, ALC and relative Power Output • Built-in CW Sidetone monitor and semi-automatic break-in CW • Built-in power supply • Maximum TVI protection • Employs only 3 vacuum tubes • The price . . . only $365.00*

THE KENWOOD **TS-511S** TRANSCEIVER

The Kenwood TS-511S is a five band SSB and CW transceiver packed with power and performance . . . offering features never before available in its price range. For example: built-in VOX, crystal calibrator, noise blanker, receiver incremental tuning, 1 kHz frequency readout, 8 pole filter, stable FET VFO, dual conversion and accessory CW filter.

FREQUENCY RANGE:

80 meter band	3.5 - 4.1 mHz
40 meter band	7.0 - 7.6 mHz
20 meter band	14.0 - 14.6 mHz
15 meter band	21.0 - 21.6 mHz
10 meter band	28.0 - 28.6 mHz
	28.5 - 29.1 mHz
	29.1 - 29.7 mHz

MODES: LSB, USB, CW

INPUT POWER:
500 watts PEP, 300 watts CW nominal.

SENSITIVITY:
3.5-21.6 mHz band; 0.5 uv S/N 10 db
28.0-29.7 mHz band; 1.5 uv S/N 10 db
and less than 100 cps frequency drift per 30 minutes after warm-up

SELECTIVITY:
SSB more than 2.4 KC (at 6 db) with 2 to 1 slope ratio
CW more than 0.5 KC (at 6 db)

AUDIO OUTPUT: more than 1 watt (10% distortion)

TUBE & SOLID STATE COMPONENTS:
10 Tubes, 1 IC, 37 Transistors, 4 FET, 52 Diodes

PRICE: $398.00

ACCESSORIES:
Power Supply with built-in speaker $105.00
External VFO $99.00
CW Filter $35.00

**Prices subject to import surcharge*